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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	Docket No. 52-007-ESP
Exelon Generation Company, LLC	ASLBP No. 04-821-01-ESP
(Early Site Permit for Clinton ESP Site)	March 17, 2005

EXELON'S MOTION FOR SUMMARY DISPOSITION OF CONTENTION 3.1

I. INTRODUCTION

The sole Intervenors in this proceeding are Environmental Law and Policy Center, Blue Ridge Environmental Defense League, Nuclear Energy Information Service, Nuclear Information and Resource Service, and Public Citizen (collectively Intervenors). Only one of their contentions, Contention 3.1, was admitted for litigation in this proceeding. As admitted by the Licensing Board, Contention 3.1 alleges that Exelon Generation Company's (EGC) Environmental Report (ER) is "premised on several material legal and factual flaws that lead it to improperly reject the better, lower-cost, safer, and environmentally preferable wind power and solar power alternatives, and fails to address adequately a mix of these alternatives along with the gas-fired generation and 'clean coal' resource alternatives."[1] The Licensing Board has categorized this contention as a "contention of omission"—a contention that alleges that the application omits a discussion of a necessary subject.[2]

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1 Memorandum and Order (Ruling on Standing and Contentions), LBP-04-17, at 24 (Aug. 6, 2004) ("Memorandum and Order").

2 Order (Sept. 30, 2004), at 2.

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As explained in further detail below, EGC has cured this alleged omission. In response to the Nuclear Regulatory Commission (NRC) Staff's Request for Additional Information E9.2-1 regarding Contention 3.1, EGC has identified revisions to the relevant sections in Chapter 9 of the ER for the EGC Early Site Permit (ESP) facility (EGC ESP facility) (RAI Response).[3] The RAI Response provides a detailed analysis of wind and solar power, including combinations of these alternatives with coal and natural gas-fired facilities that together could generate baseload power in an amount equivalent to the proposed EGC ESP facility. Since the RAI Response provides the information sought by Contention 3.1, the Licensing Board should grant summary disposition of Contention 3.1.

In addition to curing the alleged omission, EGC has also evaluated the information that the Intervenors have provided or cited in support of Contention 3.1, including documents provided by Intervenors as Exhibits to Contention 3.1 and documents identified by the Intervenors as part of their discovery disclosures pursuant to 10 CFR § 2.336. As shown in this motion, the RAI Response provides a bounding analysis of wind and solar power that encompasses the information provided and cited by the Intervenors. Similarly, the NRC Staff's analysis of the alternatives of wind and solar power in the *Draft Environmental Impact Statement for an Early Site Permit (ESP) at the Clinton Site*, (DEIS) NUREG-1815 (February 2005), Chapter 8, is fully consistent with the RAI Response. Therefore, there is no genuine issue of material fact regarding wind and solar power (and combinations involving them). This provides a separate ground for summary disposition of Contention 3.1.

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[3] The RAI Response is attached to a letter dated September 23, 2004 from Marilyn C. Kray (EGC) to the NRC. Counsel for EGC served a copy of this letter upon the Licensing Board and the other parties by letter dated September 24, 2004.

Accordingly, EGC files this Motion for Summary Disposition of Intervenors' Contention 3.1 pursuant to 10 CFR § 2.1205. This motion is supported by a separate "Statement of Material Facts on Which No Genuine Issue Exists" and by a sworn Joint Affidavit from William D. Maher and Curtis L. Bagnall (Maher & Bagnall Aff.)

Since Contention 3.1 is the only contention that has been admitted in this proceeding, a grant of summary disposition of Contention 3.1 will resolve all of the contested issues in this proceeding. Therefore, if the Licensing Board grants this motion, it should also dismiss Intervenors from this proceeding.

II. PROCEDURAL BACKGROUND

On September 25, 2003, EGC filed an ESP application seeking approval of the existing Clinton nuclear power station site in Dewitt County, Illinois, for the possible construction of one or more new nuclear reactors. The ESP application consisted of a section on Administrative Information about EGC, a Site Safety Analysis Report, emergency planning information, an ER, and a Site Redress Plan.

On May 3, 2004, Intervenors filed proposed Contention 3.1, entitled "The Clean Energy Alternatives Contention—The Environmental Review Fails to Rigorously Explore and Objectively Evaluate All Reasonable Alternatives." Contention 3.1 alleged several shortcomings with respect to EGC's evaluation of alternatives to the EGC ESP facility, including: (1) "the evaluation of alternatives is improperly constrained because the NRC regulations provide that Exelon's application need not analyze the need for power"; (2) "the ER treats each alternative energy source as a discrete alternative" and does not consider alternatives in combination; (3) "the ER improperly rejects the reasonable alternative of meeting energy needs through increased energy efficiency efforts"; and (4) "the ER relies on flawed and outdated information" to support its conclusion that wind and solar power are not reasonable alternatives to new nuclear power generation.[4]

In its Memorandum and Order of August 6, 2004, the Licensing Board admitted, in-part, Contention 3.1. Contention 3.1, as admitted, asserts that:

> The Environmental Review fails to rigorously explore and objectively evaluate all reasonable alternatives. In Section 9.2 of the Environmental Report, Exelon claims to satisfy 10 CFR 51.45(b)(3), which requires a discussion of alternatives that is "sufficiently complete to aid the Commission in developing and exploring" "appropriate alternatives . . . concerning alternative uses of available resource" pursuant to the National Environmental Policy Act. However, Exelon's analysis is premised on several material legal and factual flaws that lead it to improperly reject better, lower-cost, safer, and environmentally preferable wind power and solar power alternatives, and fails to address adequately a mix of these alternatives along with the gas-fired generation and "clean coal" resource alternatives. Therefore, Exelon's ER does not provide the basis for the rigorous exploration and objective evaluation of all reasonable alternatives to the ESP that is required by NEPA.[5]

In admitting Contention 3.1 with respect to wind and solar power, the Licensing Board rejected those portions of Intervenors' proposed Contention 3.1 that pertained to need for power and energy conservation on the ground that those matters are outside the scope of this proceeding.[6] In this regard, the Licensing Board also ruled that it is not necessary to consider "alternative generation methods that are not typically employed by independent power generators," because consideration of such methods would essentially equate to an analysis of need for power.[7]

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4 Supplemental Request for Hearing and Petition to Intervene by Environmental Law and Policy Center, Blue Ridge Environmental Defense League, Nuclear Information and Resource Service, Nuclear Energy Information Service, and Public Citizen, Contention 3.1—The Clean Energy Alternatives Contention ("Intervenors' Contention 3.1") (May 3, 2004), at 2.

5 Memorandum and Order, at 24.

6 Memorandum and Order, at 16–17.

7 Memorandum and Order, at 16–17.

On March 3, 2005, the NRC Staff issued its DEIS for the Clinton ESP. Chapter 8 of the DEIS includes an evaluation of various alternative generating sources such as wind and solar power, including combinations of alternatives that, together, could generate baseload power in an amount equivalent to the EGC ESP facility. In sum, as stated in the DEIS, the NRC Staff reviewed the RAI Response's analysis of wind and solar power and agrees with EGC's conclusion that wind and solar generation are not reasonable alternatives to the proposed EGC ESP facility.[8] Further, the DEIS concludes that the EGC ESP facility would be either environmentally preferable or equivalent to the combination of power generation alternatives.[9]

III. STATEMENT OF THE LAW GOVERNING SUMMARY DISPOSITION MOTIONS ON ALTERNATIVE ENERGY SOURCES

A. Law Governing Summary Disposition

As provided in the Licensing Board's Memorandum and Order, this proceeding is governed by Subparts C and L in 10 CFR Part 2.[10] As provided by 10 CFR § 2.1205, Subpart L, any party may submit a motion for summary disposition at least 45 days before the commencement of hearings.[11] The motion must be in writing and include a written explanation of the basis of the motion, and affidavits to support statements of fact.[12] Other parties may serve

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8 *See* DEIS, at 8-16–8-18 (evaluating and concluding that wind and solar power are not reasonable alternatives to the proposed EGC ESP facility).

9 *See* DEIS, at 8-21–8-22 (evaluating the environmental impacts relative to a combination of alternatives and concluding that the EGC ESP facility would be either environmentally preferable or equivalent to such a combination).

10 Memorandum and Order, at 20.

11 10 CFR § 2.1205(a).

12 *Id.*

an answer 20 days after service of the motion.[13] In ruling on the motion, the Licensing Board is directed to apply the standards for summary disposition set forth in Subpart G of Part 2.[14]

Pursuant to 10 CFR § 2.710, Subpart G, summary disposition "as to all or any part of the matters involved in the proceeding"[15] is warranted "if the filings in the proceeding, depositions, answers to interrogatories, and admissions on file, together with the statements of the parties and the affidavits, if any, show that there is no genuine issue as to any material fact and that the moving party is entitled to a decision as a matter of law."[16] Section 2.710 generally retains the provisions in former Section 2.749 prior to the revision of Part 2 in January 2004.[17] Therefore, precedents under the former Section 2.749 are applicable to motions for summary disposition under the current provisions in 10 CFR § 2.710 and § 2.1205.

The Commission has held that motions for summary disposition under Section 2.749 are analogous to summary judgment motions under Rule 56 of the Federal Rules of Civil Procedure, and should be evaluated by the same standards.[18] As held by both the courts and the NRC Appeal Board, summary disposition is not simply a "procedural shortcut"; rather, it is designed "to secure the just, speedy and inexpensive determination of every action," and should be granted when appropriate.[19]

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13 10 CFR § 2.1205(b).

14 10 CFR § 2.1205(c).

15 10 CFR § 2.710(a).

16 10 CFR § 2.710(d)(2).

17 69 Fed. Reg. 2182, 2227 (Jan. 14, 2004).

18 *Advanced Med. Sys., Inc.* (One Factor Row, Geneva, Ohio 44041), CLI-93-22, 38 NRC 98, 102 (1993).

19 *Celotex Corp. v. Catrett*, 477 U.S. 317, 327 (1986) (citations omitted); *see also Tenn. Valley Auth.* (Hartsville Nuclear Plant, Units 1A, 2A, 1B, 2B), ALAB-554, 10 NRC 15, 19 (1979).

Pursuant to both the NRC and federal caselaw, the party seeking summary disposition bears the burden of showing the absence of a genuine issue as to any material fact.[20] In response, the party opposing the motion "must set forth specific facts showing that there is a genuine issue of fact."[21] To be considered a genuine issue of material fact, "the factual record, considered in its entirety, must be enough in doubt so that there is a reason to hold a hearing to resolve the issue."[22] Bare allegations or general denials are insufficient to oppose a motion for summary disposition,[23] as are mere "quotations from or citations to [the] published work of researchers [or experts] who have apparently reached conclusions at variances with the movant's affiants."[24] Furthermore, if the party opposing the motion fails to controvert any material fact properly set out in the statement of material facts that accompanies a summary disposition motion, then that fact will be deemed admitted.[25]

If the moving party makes a proper showing, and the opposing party does not show that a genuine issue of material facts exists, then the Licensing Board may summarily dispose of the contentions on the basis of the pleadings.[26] As discussed below, Intervenors' Contention 3.1 is

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20 *Adickes v. S.H. Kress & Co.*, 398 U.S. 144, 157 (1970); *Advanced Med. Sys., Inc.*, 38 NRC at 102.

21 10 CFR § 2.710(b) (emphasis added).

22 *Cleveland Elec. Illuminating Co.* (Perry Nuclear Power Plant, Units 1 and 2), LBP-83-46, 18 NRC 218, 223 (1983).

23 *See* 10 CFR § 2.710(b) (stating that "a party opposing the motion may not rest upon the mere allegations or denials of his answer"); *Advanced Med. Sys., Inc.*, 38 NRC at 102; *Houston Lighting and Power Co.* (Allens Creek Nuclear Generating Station, Unit 1), ALAB-629, 13 NRC 75, 78 (1981).

24 *Carolina Power & Light Co.* (Shearon Harris Nuclear Plant, Units 1 and 2), LBP-84-7, 19 NRC 432, 435–36 (1984); *see also United States v. Various Slot Machines on Guam*, 658 F.2d 697, 700 (9th Cir. 1981) (holding that "in the context of a motion for summary judgment, an expert must back up his opinion with specific facts" in an affidavit).

25 10 CFR § 2.710(a); *Advanced Med. Sys., Inc.*, 38 NRC at 102–03.

26 *Northern States Power Co.* (Prairie Island Nuclear Generating Plants, Units 1 and 2), CLI-73-12, 6 AEC 241, 242 (1973), aff'd sub. nom. *BPI v. AEC*, 502 F.2d 424 (D.C. Cir. 1974).

clearly the type of contention for which no evidentiary hearing is necessary, and which can be readily and expeditiously resolved in EGC's favor through summary disposition procedures.

B. Law Governing Consideration of Alternative Generating Sources

Contention 3.1 and the evaluation of alternative generating sources are governed by the National Environmental Policy Act of 1969 (NEPA), 42 U.S.C. §§ 4321 *et seq.*, and the NRC's associated regulations in 10 CFR Part 51. NEPA establishes a "broad national commitment to protecting and promoting environmental quality."[27] These policy goals are realized through a set of "action-forcing" procedures that require that agencies take a "'hard' look at environmental consequences, and that provide for broad dissemination of relevant environmental information."[28] It is also "well settled that NEPA itself does not mandate particular results, but simply prescribes the necessary process."[29]

NEPA and the NRC's regulations in 10 CFR Part 51 require an analysis of alternatives to a proposed licensing action. The "rule of reason" guides "both the choice of alternatives as well as the extent to which the [EIS] must discuss each alternative."[30] Thus, the alternatives analysis "must consider not every possible alternative, but every reasonable alternative."[31]

Under NEPA, the reasonableness of an alternative is judged by whether the alternatives will accomplish the goals or purpose of the project. The Commission has held that agencies need only discuss alternatives that are reasonable and "will bring about the ends" of the proposed

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27 *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 348 (1989).

28 *Id.* at 350.

29 *Id.*

30 *Private Fuel Storage, LLC* (Independent Spent Fuel Storage Installation), LBP-03-30, 58 NRC 454, 479 (2003) *(quoting City of Carmel-by-the Sea v. Dept. of Transp.*, 123 F.3d 1142, 1155 (9th Cir. 1997)) (brackets in original).

31 *Id. (quoting Long Island Lighting Co.* (Shoreham Nuclear Power Station, Unit 1), CLI-91-02, 33 NRC 61, 71 (1991)).

action.[32] Similarly, the courts have held that "the goals of an action delimit the universe of the action's reasonable alternatives."[33] Where a federal agency is not the sponsor of a project, the "consideration of alternatives may accord substantial weight to the preferences of the applicant and/or sponsor in the siting and design of the project."[34]

The stated purpose of the EGC ESP facility is to be a merchant generator to produce baseload power for sale on the wholesale market.[35] In the past, the Intervenors have argued that the purpose of the EGC ESP facility is to meet the energy needs of Illinois.[36] Supplying energy needs is obviously an important benefit of the project, and consideration of need for power from the project is required to be addressed as part of a combined license proceeding for the project. However, the purpose of the EGC ESP facility, as stated in the ESP application, is much more specific than simply supplying regional energy needs. The ESP application explicitly states that the purpose of the project is to produce baseload power for sale on the wholesale market. Intervenors are not allowed to redefine EGC's purpose for the project. As stated in *Citizens Against Burlington*:

> An agency cannot redefine the goals of the proposal that arouses the call for action; it must evaluate alternative ways of achieving *its* goals, shaped by the application at issue and by the function that the agency plays in the decisional process. Congress did expect agencies to consider an applicant's

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32 *Hydro Res., Inc.*, CLI-01-04, 53 NRC 31, 55 (2001).

33 *Citizens Against Burlington, Inc. v. Busey*, 938 F.2d 190, 195 (D.C. Cir. 1991), *cert. denied*, 502 U.S. 994 (1991).

34 *City of Grapevine, Tex. v. Dep't of Transp.*, 17 F.3d 1502, 1506 (D.C. Cir. 1994), *cert. denied*, 513 U.S. 1043 (1994).

35 *Exelon Generation Company, LLC Statement of Material Facts* ("Statement of Material Fact") # I.B.1.

36 *See, e.g.*, Petition of Intervenors Environmental Law and Policy Center, Blue Ridge Environmental Defense League, Nuclear Information and Resource Service, Nuclear Energy Information Service, and Public Citizen for Interlocutory Review of the Licensing Board Panel's Rejection of Energy Efficiency Alternatives Contention (Aug. 23, 2004), at 9.

> wants when the agency formulates the goals of its own proposed action. Congress did not expect agencies to determine for the applicant what the goals of the applicant's proposal should be.[37]

As the Licensing Board has ruled in this proceeding, "it is appropriate for the applicant fully to consider its own business objectives and status as an independent power producer - - as opposed to a public utility - - as it analyzes alternatives."[38] Therefore, alternatives that cannot supply baseload power are not reasonable alternatives to the proposed EGC ESP facility because they cannot accomplish the purpose of the facility.

In deciding whether an alternative is preferable to the proposed project, the analysis must look at "alternatives available for reducing or avoiding adverse environmental effects."[39] NEPA, however, "does not require the selection of the most environmentally benign alternative."[40] Instead, NEPA requires only that the adverse environmental effects of the proposed action be adequately identified and evaluated.[41] Therefore, an agency is not constrained by NEPA from deciding that other values (such as economic cost) outweigh environmental issues.[42] On the other hand, if an alternative is not environmentally preferable, "such cost-benefit balancing does not take place," and the alternative need not be considered further.[43] Accordingly, if it is determined that the EGC ESP facility is environmentally preferable, NEPA does not require this Licensing Board to "sift through environmentally inferior alternatives to find a cheaper (but

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37 938 F.2d at 380.

38 Memorandum and Order, at 16–17.

39 *Private Fuel Storage*, 58 NRC at 478 (*quoting* 10 CFR § 51.71(d)).

40 *Id.* at 479. (*quoting Robertson*, 490 U.S. at 351).

41 *Robertson*, 490 U.S. at 350 (*citing Strycker's Bay Neighborhood Council, Inc. v. Karlen*, 444 U.S. 223, 227–228 (1980) (per curiam)).

42 *Id.*

43 *Consumers Power Co.* (Midland Plant, Units 1 and 2), ALAB-458, 7 NRC 155, 162 (1978).

dirtier) way of handling the matter at hand."[44] NEPA does not give the NRC the "authority to reject an applicant's proposal solely because an alternative might prove less costly financially."[45] Thus, "in order to reject the Applicant's proposal, it would have to be determined *both* that (1) at least one of the alternatives [is] environmentally superior; *and* (2) that environmental superiority [is] not outweighed by other considerations such as comparative costs."[46]

In categorizing and comparing the environmental impacts of alternatives, it is now standard NRC practice to assign each impact a "significance level." In particular, the NRC has established the following three significance levels for the purpose of evaluating environmental impacts:

- SMALL--For the issue, environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource.
- MODERATE--For the issue, environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource.
- LARGE--For the issue, environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.

These significance levels are currently embodied in NRC's environmental regulations in 10 CFR Part 51, Table B-1, as they pertain to license renewal of nuclear power plants. These significance levels are also used in the ER and RAI Response, as well as the DEIS.[47] EGC urges the Licensing Board to accept this classification approach as a useful tool for comparing the environmental impacts of alternatives relative to the EGC ESP facility. We believe that this

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44 *See id.* (evaluating the role of economic costs under NEPA analysis).

45 *Florida Power & Light Co.* (Turkey Point Nuclear Generating, Unit Nos. 3 and 4), ALAB-660, 14 NRC 987, 1007 (1981).

46 *Virginia Elec. and Power Co.* (North Anna Nuclear Power Station, Units 1 and 2), ALAB-584, 11 NRC 451, 458 (1980) (emphasis in original).

approach for classification of environmental impacts is especially useful in comparing environmental impacts from substantially different types of generating sources, such as wind, solar, fossil-fueled facilities, and nuclear power plants.

For example, wind power entails environmental impacts associated with bird deaths due to collisions with the blades of the wind turbines, while nuclear power plants pose little threat due to bird collisions. However, the RAI Response has categorized the risk to birds from wind power as SMALL. Therefore, even though more bird deaths are expected from wind facilities than a nuclear facility, we consider the impacts from wind facilities to be on par with those from a nuclear facility, since the impacts from the wind facilities are classified as SMALL. We believe that a similar approach is warranted with respect to each type of environmental impact. Thus, an alternative generating source should be considered environmentally preferable if its environmental impacts have a significance level that is less than the environmental impacts of the proposed facility (*e.g.*, the impacts from the alternative facility are SMALL while the impacts from the proposed facility are MODERATE or LARGE).

IV. THERE ARE NO GENUINE ISSUES OF MATERIAL FACT RELATED TO CONTENTION 3.1, AND EGC IS ENTITLED TO JUDGMENT AS A MATTER OF LAW

As discussed above, the Licensing Board has characterized Contention 3.1 as a "contention of omission." As discussed in Section A below, EGC has now cured the alleged omissions by submitting the RAI Response. Because EGC has now supplied the allegedly missing information, it is entitled to summary disposition of Contention 3.1

Additionally, as discussed in Section B below, there is no genuine issue of material fact regarding the alternative energy sources of wind and solar power, including combinations

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[47] ER, at Table 9.2-6; *Exelon Generation Company LLC Response to RAI E.9.2-1 regarding Clean Energy Alternatives, Enclosure 2*, (Sept. 23, 2004) ("RAI Resp."), at Tables 9.2-6 and 9.2-7; DEIS, at xxvi–xxvii.

thereof. This absence of any dispute regarding a material fact provides another basis for granting summary disposition of Contention 3.1.

As is discussed below, EGC believes that there is no genuine issue of material fact related to Contention 3.1. However, if the Licensing Board finds one or more material facts to be in dispute, EGC requests that the Licensing Board grant summary disposition with respect to those material facts that are not in dispute in order to narrow the scope of the hearings and avoid needless repetition in the hearing phase of this proceeding.

A. **The Omission Alleged in Contention 3.1 Has Been Cured by the Information Provided by EGC in its RAI Response.**

The Licensing Board has ruled that Contention 3.1 identifies two alleged omissions: (1) "a failure by EGC in its evaluation of the alternatives that could be used by an independent power provider in its power generation mix adequately to address a combination of wind power, solar power, natural gas-fired generation, and 'clean coal' technology;" and (2) EGC's "use of potentially flawed and outdated information regarding wind and solar power generation methods . . . ."[48] As discussed below, the RAI Response provides information that addresses each of these issues. Therefore, EGC has cured the alleged omissions.

First, Contention 3.1 alleges that the ER lacks consideration of wind and solar generation and each alternative energy in combination with coal and natural gas-fired facilities. As demonstrated in Section IV.B of this motion, the RAI Response considers in detail these alternatives separately and a mix of these alternatives along with the natural gas-fired generation and coal resource alternatives. Similarly, Chapter 8 of the DEIS evaluates wind and solar power, including combinations of alternatives that, together, could generate baseload power in an amount equivalent to the EGC ESP facility. Both the RAI Response and the DEIS contain a

[48] Memorandum and Order, at 17.

variety of information related to combinations of wind and solar power and coal and natural gas-fired facilities, including information related to costs and environmental impacts. Therefore, the record now contains information regarding the alternatives identified in Contention 3.1, thereby curing the alleged omission.

Second, Contention 3.1 alleges that the ER's analysis of wind and solar power relies upon outdated information. The RAI Response, with respect to wind and solar power (and a mix of these with natural gas-fired generation and coal technologies), is based upon current information.[49] This updated information includes references to 24 reports issued between 2001 and 2004, including a number of reports on wind and solar power issued by the U.S. Department of Energy (DOE) in 2004, together with references to some of the Intervenors' Exhibits[50] (*e.g.*, Intervenors' Exhibit 3). Similarly, Chapter 8 of the DEIS provides references to recent sources (including DOE reports) for its evaluation of wind and solar power, and combinations of alternatives that could generate baseload power in an amount equivalent to the EGC ESP facility. This new information cures the second omission alleged by Contention 3.1.

Accordingly, Contention 3.1 is moot. As the Commission has clearly stated:

> [t]here is, in short, a difference between contentions that merely allege an "omission" of information and those that challenge substantively and specifically how particular information has been discussed in a license application. Where a contention alleges the omission of particular information or an issue from an application, and the information is later supplied by the applicant or considered by the Staff in a draft EIS, the contention is moot.[51]

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49 Maher & Bagnall Aff. at § III.

50 Maher & Bagnall Aff. at § III.

51 *Duke Energy Corp.* (McGuire Nuclear Station, Units 1 and 2; Catawba Nuclear Station, Units 1 and 2), CLI-02-28, 56 NRC 373, 382–383 (2002).

Therefore, the omissions as alleged in Contention 3.1 have been addressed by EGC in its RAI Response and by the DEIS. As a result, the Licensing Board should grant summary disposition of Contention 3.1.[52]

B. There is No Dispute of Material Fact Regarding Wind, Solar, and Combination of Alternative Energy Sources.

In addition to curing the alleged omissions, as discussed below, EGC has also evaluated the information provided in Chapter 8 of the DEIS and the information that the Intervenors have provided or cited in support of Contention 3.1, including documents identified by the Intervenors as part of their discovery disclosures pursuant to 10 CFR § 2.336. As explained in the Maher & Bagnall Affidavit, the DEIS is fully consistent with and is bounded by the information in the RAI Response.[53] Additionally, the Maher & Bagnall Affidavit evaluates each of Intervenors' Exhibits in support of Contention 3.1 and the documents identified by Intervenors in their discovery disclosures. As shown in the Maher & Bagnall Affidavit, the information cited by the Intervenors is bounded by the information in the RAI Response and therefore does not raise any genuine issue of material fact regarding EGC's analysis of wind and solar power (and combinations involving them). This evaluation provides a separate ground for granting summary disposition of Contention 3.1.

The following sections demonstrate that there is no genuine issue of material fact on the purpose, availability, costs, and environmental impacts of:

- the EGC ESP facility;
- wind power facilities by themselves;

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[52] *See, e.g., Duke Cogema Stone & Webster* (Savannah River Mixed Oxide Fuel Fabrication Facility), LBP-04-9, 59 NRC 286, 293, 295 (2004) (finding summary disposition appropriate where the Applicant provided the omitted analysis rendering the contentions of omission moot).

[53] Maher & Bagnall Aff. at § VI.

- solar facilities by themselves;
- combinations of wind and solar facilities alone and in combination and with (i) energy storage systems and (ii) coal and natural gas-fired facilities.

1. *Uncontested Facts Relative to the EGC ESP Facility*

The Intervenors have not submitted a contention regarding the location, purpose, capacity, or environmental impacts of the EGC ESP facility as described in the ER. Therefore, the facts related to these matters are not in dispute in this proceeding.

In particular, the ER contains the following uncontested information regarding the EGC ESP facility:

- Location - - The EGC ESP is located within the boundary of the Clinton Power Station (CPS) property.[54] The site is located in Dewitt County, Illinois, approximately six miles east of the City of Clinton and along the shore of Clinton Lake.[55] The EGC ESP facility will be built about 700 feet south of the existing CPS.[56]
- Purpose - - The purpose of the EGC ESP facility is to operate as a baseload merchant generator.[57] The power produced will be sold on the wholesale market, without specific consideration to supplying a traditional service area or satisfying a reserve margin objective.[58]

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54 Statement of Material Fact # I.A.1.

55 Statement of Material Fact # I.A.1.

56 Statement of Material Fact # I.A.1.

57 Statement of Material Fact # I.B.1.

58 Statement of Material Fact # I.B.1.

- Capacity - - The installed capacity of the EGC ESP facility will be approximately 2,180 MWe.[59] Based upon a capacity factor of 90%, which currently is about the average capacity of operating nuclear power plants in the United States, the EGC ESP Facility would have an average annual energy output of about 17,200,000 MWh.[60]
- Environmental Impacts - - The environmental impacts upon land use, water use, water and air quality, ecological resources, threatened and endangered species, human health, socioeconomics, waste management, aesthetics, cultural resources, and accidents relative to the EGC ESP facility are all SMALL.[61]

In addition to these uncontested facts in the ER, the RAI Response and the attached affidavit provide information regarding the cost of the EGC ESP facility. Specific cost data for the EGC ESP facility does not exist because a design has not been selected.[62] However, the projected cost of electricity associated with the operation of a new nuclear facility is in the range of $0.031–$0.046 per kWh for plants that have been previously built.[63] An upper bounding value for the cost of electricity associated with a first-of-a-kind nuclear plant at the Clinton ESP site is about $0.055 per kWh.[64]

59 Statement of Material Fact # I.C.1.

60 Statement of Material Fact # I.C.1.

61 Statement of Material Fact # I.E.1–I.E.14.

62 Statement of Material Fact # I.D.1.

63 Statement of Material Fact # I.D.2

64 Statement of Material Fact # I.D.2

2. *There is No Genuine Issue of Material Fact on Wind Power as an Alternative to the EGC ESP Facility*

There are sites in Illinois that may be suitable for generation of electricity through wind power. However, as demonstrated below, it is undisputed that wind power alone (i) is unable to generate baseload power and therefore cannot serve the purpose of the EGC ESP facility, (ii) has higher costs in Illinois than a nuclear power plant, and (iii) has some environmental impacts (*e.g.*, impacts on land usage) that are greater than the impacts from the proposed EGC ESP facility. Therefore, wind power, by itself, is not a reasonable or preferable alternative to the EGC ESP facility.

a. There Are Potential Wind Power Sites in Illinois

Wind resources are characterized by wind power density classes, which include, at a height of fifty meters and average wind speed, Class 1 (less than 12.5 mph), Class 2 (12.5–14.3 mph), Class 3 (14.3–15.7 mph), Class 3+ (15.5–15.7), Class 4 (15.7–16.8 mph), Class 5 (16.8–17.9 mph), Class 6 (17.9–19.7 mph), and Class 7 (greater than 19.7 mph).[65] Class 4 wind sites and above are regarded as potentially economical for wind energy production.[66] Class 3+ areas may also be economical for wind development with advances in technology and financial incentive support.[67]

In Illinois, there are no Class 5 wind sites or higher.[68] The total amount of Class 4 (600 km^2) and Class 3+ (1,200 km^2) lands in Illinois is 1,800 km^2.[69] The total wind potential for

65 Statement of Material Fact # II.A.2.

66 Statement of Material Fact # II.A.3.

67 Statement of Material Fact # II.A.3.

68 Statement of Material Fact # II.A.4.

69 Statement of Material Fact # II.A.4–5.

Illinois' Class 4 (3,000 MW) and Class 3+ (6,000 MW) is about 9,000 MW of installed capacity.[70] Currently, there is one operating wind power project in Illinois with an installed capacity of 50 MW, which produces less than 0.1% (0.0001) of the annual electric sales, based upon 2002 sales levels for Illinois.[71]

b. Wind Power Alone Cannot Generate Baseload Power

Baseload power assumes that a facility is continuously producing power, except for refueling, planned, and forced outages.[72] Wind power, alone, cannot generate baseload power.[73] As stated in the RAI Response[74] and the DEIS,[75] and as stated in some of the Intervenors' own exhibits,[76] wind power is intermittent and cannot provide steady or firm power. At a Class 4 site, the average annual output of a wind power plant is typically about 25% of the installed capacity.[77] The National Electric Reliability Council (NERC) credits wind capacity at about 17% in Class 4 areas.[78] More optimistic assessments place the capacity factor at a Class 4 wind facility at about 29%, and 35% in 2020 (compared to about 90% for a nuclear plant).[79]

Therefore, wind power cannot accomplish the purpose of the EGC ESP facility—namely, to generate baseload power. For this reason alone, wind power by itself is not a reasonable

70 Statement of Material Fact # II.A.6.

71 Statement of Material Fact # II.A.9.

72 Statement of Material Fact # II.A.1.

73 Statement of Material Fact # II.A.1.

74 RAI Resp., at 5, 8, and 14.

75 DEIS, at 8-17.

76 *See, e.g.*, Intervenors' Ex. 3 at 32, Ex. 14 at 18, and Ex. 15 at 8.

77 Statement of Material Fact # II.A.7.

78 Statement of Material Fact # II.A.7.

79 Statement of Material Fact # II.A.7.

alternative to the EGC ESP facility. As discussed in detail in Section III.B above, an alternative that does not accomplish the purpose of a proposed project is not a reasonable alternative to the project.

c. Wind Power In Illinois Is Currently More Costly than Nuclear Power

During the 1980's, the cost of electricity from utility-scale wind power projects was approximately $0.30/kWh.[80] Today, even with improvements in wind turbine technology, production tax credits, and benefits from the "economies of scale," the cost of wind power generation ranges from $0.03–0.06/kWh.[81] The range of costs reflects the windiness of the site, the size of the plant, and the availability of tax credits and other factors.[82] Given the relatively low classification of the wind areas in Illinois, the cost of electricity from wind facilities at sites similar to Illinois is currently about $0.057 per kWh.[83] The cost figures in the Intervenors' own exhibits are consistent with the cost figures provided above.[84]

Conversely, the cost of producing electricity from the EGC ESP facility is expected to be in the range of $0.031–$0.046/kWh.[85] Even if a first-of-a-kind nuclear plant were constructed at the Clinton ESP site, an upper bounding cost would be $0.055/kWh.[86] Therefore, it is undisputed that wind power is not currently a preferable alternative to the EGC ESP facility based upon cost.

80 Statement of Material Fact # II.B.2.

81 Statement of Material Fact # II.B.3.

82 Statement of Material Fact # II.B.3.

83 Statement of Material Fact # II.B.3.

84 *See, e.g.*, Intervenors' Ex. 14 at 11, Ex. 15 at 6, and Ex. 16 at 1–2.

85 Statement of Material Fact # I.D.2.

86 Statement of Material Fact # I.D.2.

As discussed above, it is expected that there will be further improvements in wind power technology in the future. According to the optimistic scenarios in some of Intervenors' exhibits, wind generating costs are estimated to drop to $0.03–0.04/kWh by 2020.[87] However, even if such optimistic scenarios were to develop, the costs of wind power and nuclear power would be roughly comparable—*i.e.*, wind power would not have an obvious economic advantage over nuclear power.

In summary, it is undisputed that nuclear power is currently economically preferable to wind power. Furthermore, even if wind technology continues to improve, wind power still is not predicted to be an economically preferable alternative energy source to nuclear power in the future. Therefore, on the basis of cost, wind power is not preferable to nuclear power.

d. <u>Wind Power Is Not Environmentally Preferable to Nuclear Power</u>

As discussed above, the Intervenors have not submitted a contention regarding the description of the environmental impacts from the EGC ESP facility, as described in the ER. As discussed in the ER, all of the environmental impacts from the EGC ESP facility are categorized as SMALL.

Wind power does have some environmental impacts. These impacts include:

- Deaths to birds due to collisions[88]
- Aesthetic impacts[89]
- Noise[90]

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87 Statement of Material Fact # II.B.5.

88 Statement of Material Fact # II.C.4.

89 Statement of Material Fact # II.C.6.

90 Statement of Material Fact # II.C.5.

The impacts in the latter two areas could be SMALL to LARGE, depending upon the amount of wind power used. However, EGC believes that it is possible to mitigate these impacts through remote placement of the wind facilities. Therefore, with such mitigation measures, EGC would categorize each of these environmental impacts as SMALL.[91]

Although wind power impacts on water and air quality, ecological resources, threatened and endangered species, human health, waste management aesthetics, and cultural resources are SMALL, wind power does use a relatively large amount of land,[92] even though some of the land between wind turbines may be available for other uses.[93] As indicated by the RAI Response,[94] a 2 MW turbine requires a quarter of an acre of dedicated land for the actual placement of the wind turbine, which is consistent with information cited by Intervenors.[95] If all of Illinois' 1,800 square kilometers of Class 4 and Class 3+ sites were developed using 2 MW turbines, 9,000 MW of installed capacity would utilize 1,125 acres for the placement of wind turbines.[96] Based upon a capacity factor of 17%, this project would have an average annual output of 1,530 MWe, which corresponds to 0.73 acres/MWe.[97] Even if an optimistic capacity factor of 29% is used, this

91 Statement of Material Fact # II.C.4–II.C.6.

92 Statement of Material Fact # II.C.2–II.C.3.

93 Statement of Material Fact # II.C.2.

94 RAI Resp., at 5.

95 *See, e.g.*, Intervenors' Ex. 12 at 1, Ex. 14 at 15, and Ex. 15 at 16.

96 Statement of Material Fact # II.C.3.

97 Statement of Material Fact # II.C.3.

project would occupy 0.43 acres/MWe.[98] Therefore, EGC has categorized the land impacts of wind power as SMALL to LARGE, depending upon the amount of wind power installed.[99]

Conversely, all of the environmental impacts related to the EGC ESP facility are SMALL. With respect to land use, the EGC ESP facility, operating at 90% capacity, would have an average annual output of 1,962 MWe and would only occupy approximately 461 acres (0.23 acres/MWe).[100] Accordingly, the environmental impact of wind power is greater than the impact from the EGC ESP facility. Therefore, wind power is not an environmentally preferable alternative.

e. The Bases in Contention 3.1 on Wind Power Do Not Establish a Genuine Issue of Material Fact

In Contention 3.1, Intervenors allege that EGC fails to acknowledge that wind power is a "viable and growing source of energy" that can be a reasonable alternative to the siting of a new nuclear power plant.[101] Contention 3.1 sets forth several bases in support of its claim. None of these presents a material issue of fact or law.

Intervenors' first basis for their claim is that EGC fails to acknowledge Illinois' potential capacity of "at least 3,000 MW of Class 4 wind sites and 6,000 MW of Class 3+ wind sites" is sufficient to replace the power that would be generated by a EGC ESP facility.[102] As stated above, the RAI Response accounts for Illinois' potential peak capacity of 9,000 MW from its

98 Statement of Material Fact # II.C.3.

99 Statement of Material Fact # II.C.3.

100 Statement of Material Fact # I.E.1.

101 Intervenors' Contention 3.1, at 10.

102 Intervenors' Contention 3.1, at 10–11.

Class 4 and Class 3+ wind sites.[103] However, it is undisputed that such wind facilities could not produce baseload power. Therefore, this basis does not establish a genuine issue of material fact.

Intervenors' second basis for their claim is that EGC fails to acknowledge that "technological advancements and economic advantages have led to a substantial increase in the amount of wind power installed."[104] The RAI Response acknowledges and fully considers technological advancements, such as improvements in wind turbine technologies, and economic advantages, such as the Federal Production Tax Credit and state renewable portfolio standards, that have led to increases in the amount of wind power installed.[105] Therefore, this basis does not establish a genuine issue of material fact.

Intervenors' third basis for their claim is the ER fails to acknowledge that "technological advancements are increasing the amount of power created by wind turbines."[106] Again, as stated in the preceding paragraph, the RAI Response recognizes technological advancements with respect to wind turbines, including the potential for improvements in the capacity factor of wind turbines.[107] Further, the RAI Response evaluates Illinois' Class 4 and Class 3+ wind sites using larger wind turbines than are now commercially available.[108] As Contention 3.1 indicates, in recent years, the largest commercially available wind turbines are between 1 and 1.5 MW.[109] Contention 3.1 points out General Electric is producing 2.3, 2.5, and 2.7 MW wind turbines. A

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103 RAI Resp., at 5.

104 Intervenors' Contention 3.1, at 11.

105 RAI Resp., at 5–6.

106 Intervenors' Contention 3.1, at 11.

107 RAI Resp., at 5.

108 RAI Resp., at 5.

109 Intervenors' Contention 3.1, at 11.

prototype of the 2.5 MW unit has been installed, but the unit is still not readily available for large-scale commercial use. As a result, the RAI Response evaluates the potential of Illinois' wind power assuming the use of 2 MW wind turbines.[110] Thus, the RAI Response discusses and accounts for the technological advancements that are increasing the size of wind turbines.[111] As a result, this basis does not establish a genuine issue of material fact.

Intervenors' fourth basis for their claim is the ER does not recognize that the cost of wind power has fallen dramatically since the 1980's.[112] As stated above, the RAI Response indicates that the cost of wind power generation has decreased over time.[113] Additionally, the RAI Response states that the cost of wind power is projected to continue to decrease.[114] In 2000, wind power was produced, nationally, in a range of $0.03–$0.06/kWh, and by 2020 wind power generating costs are optimistically projected to fall to $0.03–$0.04 kWh.[115] Therefore, this basis does not establish a genuine issue of material fact.

Intervenors' fifth basis for their claim is the ER limits its analysis to wind resources in Illinois.[116] The RAI Response recognizes that some Midwestern states have excellent potential for development of wind generation.[117] As the RAI Response points out, however, that wind sites far removed from the power transmission grid—whether they are located in Illinois or

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110 RAI Resp., at 5.

111 RAI Resp., at 5–6.

112 Intervenors' Contention 3.1, at 12.

113 RAI Resp., at 6.

114 RAI Resp., at 6.

115 RAI Resp., at 6.

116 Intervenors' Contention 3.1, at 12.

117 RAI Resp., at 5.

nearby states—would not be economical for generation of large amounts of power, as new transmission lines would be required to connect the wind farm to the distribution system. Furthermore, existing transmission infrastructure would need to be upgraded to handle the additional supply.[118] This is especially true in the Upper Midwest where there are very few existing East-West transmission lines and the existing transmission lines are already operating at nearly full capacity. In sum, the existing transmission system (and expected improvements) are not sufficient to support the reliable transmission of large amounts of wind power from remote sites in the Upper Midwest.[119] Therefore, this basis does not establish a genuine issue of material fact.

Intervenors' sixth basis for their claim is the ER misstates the amount of land an expansion of wind power would require, because the land between the wind turbines would be available for other uses such as agriculture.[120] As stated above, the RAI Response indicates that the land between the wind turbines is largely available for other uses,[121] as postulated by the Intervenors. The RAI Response further notes that a 2 MW turbine would require about a quarter of an acre of dedicated land for the actual placement of the wind turbine,[122] which is consistent with the information cited by the Intervenors.[123] Therefore, this basis does not establish a genuine issue of material fact.

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118 RAI Resp., at 7.

119 Statement of Material Fact # II.B.9–II.B.11.

120 Intervenors' Contention 3.1, at 12.

121 RAI Resp., at 5.

122 RAI Resp., at 5.

123 *See, e.g.*, Intervenors' Ex. 12 at 1, Ex. 14 at 15, and Ex. 15 at 16.

Intervenors' seventh basis for their claim is the ER fails to acknowledge the environmental benefits of wind power.[124] The RAI Response states that with the exception of land use and aesthetics, discussed above, the environmental impacts from wind power are SMALL.[125] The RAI Response also indicates that wind power produces no air pollution, greenhouses gases, or solid or liquid waste, and uses no coolant water.[126] Further, the RAI Response states that although wind turbines cause deaths to birds due to collisions, it classifies the impacts as SMALL.[127] Therefore, the RAI Response does acknowledge the environmental benefits of wind power. Accordingly, this basis does not establish a genuine issue of material fact.

f. Conclusions Regarding Wind Power Alone

As shown by the above discussion, there is no genuine issue of material fact on wind power as an alternative to the EGC ESP facility. In particular, there is no dispute that (i) wind power by itself cannot produce baseload power, (ii) currently the costs of electricity from wind power in Illinois are greater than the costs from a nuclear facility, and (iii) wind power is not environmentally preferable to nuclear power. Any one of these three reasons is a sufficient ground to reject wind power as an alternative.[128] Therefore, wind power by itself is not a reasonable or preferable alternative to the proposed EGC facility.

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124 Intervenors' Contention 3.1, at 12.

125 *See* RAI Resp., at 22–33 (evaluating the environmental impacts of wind power).

126 RAI Resp., at 27.

127 RAI Resp., at 28.

128 Therefore, if the Licensing Board were to find a genuine issue of material fact with respect to one or two of these reasons, it should nevertheless grant summary disposition and reject the alternative of wind power based upon the remaining undisputed reason(s).

3. *There is No Genuine Issue of Material Fact on Solar Power as an Alternative to the EGC ESP Facility*

There are sites in Illinois that may be suitable for generation of electricity through solar power. However, as demonstrated below, it is undisputed that solar power alone (i) is unable to generate baseload power, (ii) has higher generation costs than a nuclear facility, and (iii) is not environmentally preferable to a nuclear facility. Therefore, there is no genuine issue of material fact that solar power, by itself, is not a reasonable or preferable alternative to the EGC ESP facility.

a. There Are Potential Solar Power Sites in Illinois

There is a potential to generate electricity from solar power in Illinois. In Illinois, solar energy varies but is approximately 4 $kWh/m^2/day$ on average.[129] However, on average, Illinois only receives about half the solar radiation as the southwestern United States.

b. Solar Power Alone Cannot Generate Baseload Power

As discussed above, a baseload facility must be able to produce electricity continuously, except for refueling, planned, and forced outages. By definition, solar power is dependent on the availability and strength of sunlight. Solar is not available to produce power at night or on overcast days.[130] Intervenors' own exhibits note that solar power is intermittent.[131] Therefore, it is undisputed that solar power alone cannot accomplish the purpose of the EGC ESP facility—namely, to generate baseload power. For this reason alone, solar power by itself is not a reasonable alternative to the EGC ESP facility. As discussed in detail in Section III.B above, an

129 Statement of Material Fact # III.A.2.

130 Statement of Material Fact # III.A.1.

131 *See, e.g.*, Intervenors' Ex. 3 at ES-10, 50.

alternative that does not accomplish the purpose of a proposed project is not a reasonable alternative to the project.

c. Solar Power Is More Expensive than Nuclear Power

The cost of generating electricity by solar technologies—both concentrating solar thermal power systems and solar photovoltaics (PV)—is greater than from the EGC ESP facility.

As indicated in the RAI Response and DEIS, the current costs of concentrating solar power systems range from \$0.09–\$0.12/kWh.[132] Within the next few decades, the cost is optimistically expected to decrease to \$0.04–\$0.05/kWh.[133] Currently, the twenty-year life cycle cost for PV is \$0.20–\$0.50/kWh.[134] The costs of grid-connected PV systems could drop to \$0.15/kWh to \$0.20/kWh by 2020.[135] These figures are consistent with the costs provided in Intervenors' own exhibits.[136] These cost estimates, however, are for solar power facilities in the southwestern United States.[137] Unlike the southwestern part of the United States, where solar energy generates up to 10–12/kWh/m^2 of solar radiation during a summer day, the amount of solar radiation in Illinois in the summer is about half this amount.[138] Therefore, the costs of solar power in Illinois would be about twice the costs listed above.

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132 DEIS, at 8-18; RAI Resp., at 11.

133 Statement of Material Fact # III.B.2.

134 Statement of Material Fact # III.C.3.

135 Statement of Material Fact # III.C.4.

136 Intervenors' Ex. 3 at 43.

137 Statement of Material Fact # III.B.2, III.C.3–III.C.4.

138 Statement of Material Fact # III.A.2.

It is undisputed that solar power is currently more expensive, and is expected to remain more expensive, than electricity from a nuclear power plaint. As a result, the proposed EGC ESP facility is preferable to solar power on a cost basis.

d. Solar Power Is Not Environmentally Preferable to a Nuclear Plant

As discussed above, the Intervenors have not submitted a contention on the description of the environmental impacts from the EGC ESP facility, as described in the ER. As discussed in the ER, all of the environmental impacts from the EGC ESP facility are categorized as SMALL.

PV and solar thermal generation produce no air pollution, greenhouse gases, solid waste, or noise.[139] Solar power, however, does have some environmental impacts. There are thermal discharges associated with some concentrating solar facilities, and there are human health impacts associated with the manufacture, use, and disposal of solar power technologies since there is a risk of exposure to heavy metals such as selenium, cadmium, and lead.[140] Notwithstanding, the RAI Response has categorized these impacts as SMALL.[141]

There are significant land use impacts from solar power facilities. For illustrative purposes, in order for PV cells to generate an amount of electricity equivalent to that produced by the EGC ESP facility, the PV cells would require tens of square kilometers.[142] The DEIS also discusses solar power's land use impacts, estimating that PV requires 142 km^2 per 1,000 MWe and approximately 57 km^2 per 1,000 MWe for thermal systems. The RAI Response has categorized the land use requirements for a solar facility as SMALL to LARGE, depending upon

139 Statement of Material Fact # III.D.1.

140 Statement of Material Fact # III.D.1–III.D.5.

141 *See* RAI Resp., at 22–33 (evaluating the environmental impacts of solar power).

142 Statement of Material Fact # III.D.2.

the size of the facility.[143] Conversely, all of the environmental impacts related to the EGC ESP facility are SMALL.[144] With respect to land use, the EGC ESP facility, operating at 90% capacity, would have an average annual output of 1,962 MWe and occupy 461 acres (0.23 acres/MWe).[145] Therefore, the EGC ESP facility would occupy substantially less space. Accordingly, the environmental impact of solar power is greater than the impact from the EGC ESP Facility. Therefore, solar power is not an environmentally preferable alternative.

e. The Intervenors' Bases for Contention 3.1 Do Not Establish a Genuine Issue of Material Fact on Solar Power.

In Contention 3.1, Intervenors allege that the ER misstates the impacts of solar power.[146] Contention 3.1, however, alleges only one misstatement with respect to ER's solar power analysis; it alleges that the ER "provides a distorted view of the impacts of solar power . . . ignor[ing] the fact that solar power is distributed power. Many solar power units are located on rooftop of buildings . . . ."[147]

However, EGC does not have rights to place solar panels on the tops of buildings it does not own or control. Furthermore, as the Licensing Board ruled in its Memorandum and Order, alternative generation methods that are not typically employed by independent power generators are outside the scope of this proceeding.[148] Distributed solar power units on roof tops are not

143 RAI Resp., at 26.

144 ER, at Tables 9.2-6 and 9.2-7.

145 Statement of Material Fact # I.E.1.

146 Intervenors' Contention 3.1, at 13.

147 Intervenors' Contention 3.1, at 13.

148 Memorandum and Order, at 16.

typically employed by independent power generators.[149] Therefore, distributed solar power units on rooftops need not be considered in this proceeding.

f. Conclusions Regarding Solar Power Alone

As shown by the above discussion, there is no genuine issue of material fact on solar power as an alternative to the EGC ESP facility. In particular, there is no dispute that (i) solar power by itself cannot produce baseload power, (ii) the costs of electricity from solar power in Illinois are greater than the costs of electricity from a nuclear facility, and (iii) solar power is not an environmentally preferable energy alternative to nuclear power. Any one of these three reasons is a sufficient ground to reject solar power as an alternative.[150] Therefore, solar power by itself is not a reasonable or preferable alternative to the proposed EGC facility.

4. *There is No Dispute of Material Fact Regarding the Combinations of Alternatives that Could Generate Baseload Power in an Amount Equivalent to the Proposed EGC ESP Facility*

EGC has evaluated the information that the Intervenors have provided or cited in support of Contention 3.1, including documents identified by the Intervenors as part of their discovery disclosures pursuant to 10 CFR § 2.336. None of these documents addresses, in any detail, the combination of alternatives, including combinations with coal and natural gas-fired facilities.

In contrast, EGC's RAI Response and the Maher & Bagnall Affidavit extensively evaluate a combination of alternatives involving wind and solar power, energy storage systems, and/or natural gas-fired and clean coal technology. As discussed below, there is no genuine issue of material fact that (i) such combinations could generate baseload power in an amount equivalent to the proposed EGC ESP facility, (ii) the cost of electricity from such combinations

149 Statement of Material Fact # III.D.3.

150 Therefore, if the Licensing Board were to find a genuine issue of material fact with respect to one or two of these reasons, it should still grant summary disposition and reject the alternative of solar power based upon the remaining undisputed reason(s).

would be greater than the cost from the EGC ESP facility, and (iii) such combinations would not be environmentally preferable to the EGC ESP facility.

a. Combinations of Wind and Solar Power Alone

It might be postulated that combinations of wind and solar power alone could produce baseload power (*i.e.*, the solar power facilities operate in the day, the wind power facilities operate at day and night, and the wind and solar facilities are spread throughout the state making it more likely that the wind is blowing and/or the sun is shining somewhere in the state at all times). However, such a scenario is unrealistic and could not be relied upon as a dependable source of baseload power. Experience shows that there are times when the wind statewide is insufficient to generate any electricity for extended periods of time. Also, there will be many occasions when the sun is not shining and there is insufficient wind to generate power. During such periods, the wind and solar power facilities would produce insufficient or no electricity, and would need to be supplemented or replaced by significant energy storage systems or fossil-fueled facilities to produce dependable baseload power.[151]

Accordingly, there is no dispute that the combination of wind and solar facilities, alone, cannot be relied upon to produce baseload power over the long term and certainly not baseload power equivalent to that produced by the EGC ESP facility. Therefore, the amount of power produced by a combination of wind and solar power facilities cannot meet the fundamental purpose of this project.

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151 Statement of Material Fact # IV.A.1.

b. Combinations of Wind and Solar Power with Energy Storage Systems

Notably, Contention 3.1 did not discuss energy storage alternatives, and therefore the Licensing Board should rule that this combination is outside the scope of the Contention. Nevertheless, in an abundance of caution, we discuss it below.

Wind and solar facilities could be used in combination with storage systems to produce baseload power and serve the purpose of the EGC ESP facility.[152] By storing the power produced from wind and/or solar facilities and releasing it when the wind and solar facilities are not generating power, energy storage in combination with the wind and/or solar facilities would be able to generate electricity continuously.[153]

However, at the scale of the EGC ESP facility, energy storage of wind and/or solar power in Illinois is either not available or would not be economically viable.[154] For example, the storage of even one day's output at 2,180 MW is well beyond any demonstration projects using batteries, compressed air, hydrogen, or other storage mechanism and the cost of such systems, even if available, would be prohibitive.[155] Adding the significant cost of storage systems to the cost of wind or solar facilities would render the total cost non-competitive.

In the northwestern United States, existing hydropower reservoirs are used to store and release wind generation, but this approach is not available at this scale in Illinois.[156] Another energy storage alternative might be pumped storage; however, pumped storage is not available in

152 Statement of Material Fact # IV.B.1.

153 Statement of Material Fact # IV.B.1.

154 Statement of Material Fact # IV.B.2–IV.B.5.

155 Statement of Material Fact # IV.B.2–IV.B.3.

156 Statement of Material Fact # IV.B.4.

Illinois to generate such large amounts of power, and the costs to develop such storage would be prohibitive.[157]

Accordingly, there is no genuine issue of material fact on combinations involving wind and solar power with energy storage systems as an alternative to the EGC ESP facility. While combinations could produce baseload power, the costs of electricity from such combinations in Illinois would be greater than the costs from a nuclear facility and there are no commercially viable systems available for storing large amounts of energy in Illinois. Therefore, the EGC ESP facility is preferable to wind and solar facilities in combination with energy storage systems.

c. Combinations of Wind and Solar Power with Coal and/or Natural Gas-Fired Facilities Could Generate Baseload Power

Wind and solar facilities in combination with coal and/or natural gas-fired facilities could be used to generate baseload power and serve the purpose of the EGC ESP facility.[158] During those periods when the sun is not shining or the wind is not blowing, electricity could be generated from the coal or natural gas-fired facilities.[159] Therefore, the combination of these facilities could produce electricity continuously.[160]

Because wind and solar power alone cannot reliably produce baseload power, it would be necessary to construct a coal or natural gas-fired facility that has a peak capacity of 2,180 MW that, in combination with wind and/or solar facilities could reliably produce baseload power equivalent to the EGC ESP facility.[161] Whenever the wind/solar generation is less than 2,180

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157 Statement of Material Fact # IV.B.5.

158 Statement of Material Fact # IV.C.1.a.

159 Statement of Material Fact # IV.C.1.a.

160 Statement of Material Fact # IV.C.1.a.

161 Statement of Material Fact # IV.C.1.b.

MW, the coal or natural gas-fired generation would need to run to bring the total generation output to 2,180 MW.

d. The Cost of Electricity from Combinations of Solar, Wind, and Coal and/or Natural Gas-Fired Facilities Would Be Greater than the Cost of Electricity from the EGC ESP Facility

Utilization of a combination of wind/solar facilities with a coal or natural gas-fired facility to produce baseload power would increase the cost of electricity from the coal or natural gas-fired facility relative to the cost of electricity from a baseload coal or natural gas-fired facility.[162] When the wind/solar facilities are operating, they would displace generation from the coal or natural gas-fired facility.[163] As a result, the capital and fixed operating costs of the coal or natural gas-fired facility would be spread over fewer kWh, thereby increasing the cost per kWh from the coal or natural gas-fired facility and rendering its cost non-competitive with the cost of electricity from a new nuclear facility.[164]

As discussed in the previous sections, wind and solar power are not economically preferable to the ESP EGC facility. Furthermore, given the increased cost of electricity from coal or natural gas-fired facilities when used in combinations with wind/solar facilities, the cost of electricity from the coal or natural gas-fired facilities would not be preferable to the costs of power from the EGC ESP facility. Therefore, it is undisputed that the cost of electricity from combinations of facilities would be greater than the costs of electricity from the EGC ESP facility.

162 Statement of Material Fact # IV.C.2.b.

163 Statement of Material Fact # IV.C.1.a.

164 Statement of Material Fact # IV.C.2.c.

e. Combinations of Solar, Wind, and Coal and/or Natural Gas-Fired Facilities Would Not Be Environmentally Preferable to the EGC ESP Facility

Use of combinations of solar, wind, and coal or natural gas-fired facilities to produce baseload power would decrease the environmental impacts from each type of facility, relative to the environmental impacts associated with each type of facility in isolation.[165]

If the wind/solar facilities were to have a peak capacity less than the capacity of the EGC ESP facility, the construction and operational environmental impacts of the wind/solar facilities would be reduced relative to such facilities that have a capacity equivalent to the EGC ESP facility.[166] For example, if the wind/solar facilities were to have a peak capacity of 1,500 MWe (or about 75% of the capacity of the ESP EGC facility), the amount of land needed for those facilities would be approximately 75% of that needed for wind/solar facilities that had a peak capacity equivalent to that of the EGC ESP facility. The aesthetic and noise impacts of the wind facilities would also be reduced, especially if fewer facilities were needed.

The use of wind/solar facilities would reduce the fuel and fuel-burning operational impacts (*e.g.*, gaseous emissions) from a coal or natural gas-fired facility, since the wind/solar facilities would supplant the coal or natural gas-fired facility when the wind/solar facilities operate (but not the construction impacts).[167]

Even if it were possible to postulate a combination of wind/solar facilities with coal or natural gas-fired facilities so as to minimize environmental impacts, such that the environmental impacts of the combination were all postulated to be SMALL, the combination would not be

165 Statement of Material Fact # IV.D.2–IV.D.3.

166 Statement of Material Fact # IV.D.3.

167 Statement of Material Fact # IV.D.4.

environmentally preferable to the EGC ESP facility. As stated above, the Intervenors have not submitted a contention on the description of the environmental impacts from the EGC ESP facility, as described in the ER. As discussed in the ER, all of the environmental impacts from the EGC ESP facility are categorized as SMALL.[168] Therefore, at best, the combination of wind/solar and coal and/or natural gas-fired facilities would have comparable but not preferable environmental impacts relative to the EGC ESP facility.

f. Conclusions Regarding Combinations of Wind, Solar, and Coal and/or Natural Gas-Fired Facilities

As shown by the above discussion, there is no genuine issue of material fact on combinations involving wind and solar power with coal or natural gas-fired facilities as an alternative to the EGC ESP facility. Such combinations could produce baseload power. However, it is undisputed that (i) the costs of such combinations in Illinois would be greater than the costs of a nuclear facility, and (ii) such combinations would not be environmentally preferable to nuclear power. Either of these two reasons is sufficient ground to reject energy generation combinations as an alternative.[169] Therefore, wind and solar facilities in combination with coal or natural gas-fired facilities are not preferable to the EGC ESP facility.

V. CONCLUSION

In summary, the Licensing Board should grant summary disposition of Contention 3.1 for either or both of the following reasons: (1) the omissions alleged in Contention 3.1 have been cured by the RAI Response or (2) there are no genuine issues of material fact regarding costs,

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168 ER, at Tables 9.2-6 and 9.2-7

169 Therefore, if the Licensing Board were to find a genuine issue of material fact with respect to one of these reasons, it should still grant summary disposition and reject the alternative based upon the remaining undisputed reason.

environmental impacts, technological maturity of wind and solar power (and combinations thereof), or their ability to generate baseload power.

Respectfully submitted,

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	Docket No. 52-007-ESP
Exelon Generation Company, LLC	)	
	)	ASLBP No. 04-821-01-ESP
(Early Site Permit for Clinton ESP Site)	)	
	)	March 17, 2005

STATEMENT OF MATERIAL FACTS ON WHICH NO GENUINE ISSUE EXISTS IN SUPPORT OF EXELON'S MOTION FOR SUMMARY DISPOSITION OF CONTENTION 3.1

Exelon Generation Company, LLC (EGC) submits, in support of its Motion for Summary Disposition of Contention 3.1, this Statement of Material Facts as to which there is no genuine issue to be heard.

The following facts include a classification of environmental impacts from the EGC Early Site Permit (ESP) facility and various alternatives. This classification is based upon the following significance levels established by the NRC: (1) SMALL—environmental effects are not detectable or are so minor that they will neither destabilize nor noticeably alter any important attribute of the resource; (2) MODERATE—environmental effects are sufficient to alter noticeably, but not to destabilize, important attributes of the resource; and (3) LARGE—environmental effects are clearly noticeable and are sufficient to destabilize important attributes of the resource.[1]

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[1] See, e.g., 10 CFR 51, Appendix B, Table B-1, n.3; Generic Environmental Impact Statement for License Renewal of Nuclear Plants, NUREG-1437; Draft Environmental Impact Statement for an Early Site Permit (ESP) at the Clinton ESP Site (DEIS), NUREG-1815 (February 2005), at xxvi–xxvii; see also Exelon Generation Company LLC Response to RAI E.9.2-1 regarding Clean Energy Alternatives, Enclosure 2 (Sept. 23, 2004) ("RAI Resp."), at 22, 33.

In some cases, the following facts are supported with citations to exhibits attached to Intervenors' Supplemental Request for Hearing and Petition to Intervene by Environmental Law and Policy Center, Blue Ridge Environmental Defense League, Nuclear Information and Resource Service, Nuclear Energy Information Service, and Public Citizen (May 3, 2004) and the Draft Environmental Impact Statement for an Early Site Permit at the Clinton ESP Site (DEIS). The accuracy of the content of these exhibits and the DEIS has not been attested to by a competent expert, and therefore citations to these exhibits are not sufficient to support (or oppose) a motion for summary disposition. However, in each case in which an Intervenors' exhibit or the DEIS is cited, we have also provided a citation to other material that has been affirmed by the attached Joint Affidavit of William D. Maher and Curtis L. Bagnall (Maher & Bagnall Affidavit). Therefore, our purpose in citing the Intervenors' exhibits and the DEIS is not to use them as support for our statement of materials facts, but instead to indicate that they are consistent with our statement of material facts and do not raise any genuine issue of material fact.

I. EGC ESP Facility

A. Location of EGC ESP Facility

1. The EGC ESP site is located within the boundary of the Clinton Power Station (CPS) property. The site is located in DeWitt County, Illinois, approximately six miles east of the City of Clinton and along the shore of Clinton Lake. The EGC ESP facility will be built about 700 feet south of the CPS. The site is zoned as industrial.[2]

[2] *Environmental Report for the Exelon Generation Company's Early Site Permit* (Sept. 25, 2003) ("ER"), at 1.1-1.

B. **Purpose**

1. EGC has designated that the purpose of the EGC ESP facility is to operate as a baseload merchant generator—the power produced will be sold on the wholesale market, without specific consideration to supplying a traditional service area or satisfying a reserve margin objective.[3]

C. **Capacity**

1. The capacity of the EGC ESP facility will be approximately 2,180 MWe.[4] Based upon a capacity factor of 90%, which is currently about the average capacity of operating nuclear power plants in the United States, the EGC ESP facility would have an average annual power output of approximately 1,962 MWe and an average annual energy output of about 17,200,000 MWh.[5]

D. **Costs**

1. EGC has not selected a particular design to construct and operate at the EGC ESP site. Therefore, there are no specific cost estimates for the EGC ESP facility.[6]

2. The projected total cost of electricity associated with a new nuclear facility at the Clinton ESP site is in the range of \$0.031–\$0.046 per kWh.[7] An upper bounding value for the cost of electricity associated with a first-of-a-kind nuclear plant at the Clinton ESP site is \$0.055 per kWh.[8]

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3 ER, at 9.2-1; RAI Resp., at 14.

4 RAI Resp., at 14.

5 RAI Resp., at 6, 14.

6 Maher & Bagnall Aff. at § IV.

7 RAI Resp., at 17; Maher & Bagnall Aff. § IV.

8 Maher & Bagnall Aff. at § IV.

E. **Environmental Impacts**

1. The EGC ESP facility would consist of approximately 461 acres (or about 0.23 acres/MWe based upon the annual average output from the EGC ESP facility, operating at 90%).[9] It would be located in a previously disturbed area used for CPS.[10] Accordingly, the land use impacts of the EGC ESP facility would be SMALL.[11]

2. During operation of the EGC ESP facility, there could be some gaseous effluents from diesel engines, gas-turbines, and heating facilities.[12] The emission levels at the site boundary would be insignificant as defined by the Environmental Protection Agency (EPA).[13] Accordingly, the air quality impacts of the EGC ESP facility would be SMALL.[14]

3. The operation of the EGC ESP facility will result in heat dissipation to the atmosphere.[15] The EGC ESP facility will use cooling towers, which may utilize either wet or dry cooling.[16] The heat discharge from the cooling towers will be manifested in the form of thermal and/or vapor plumes from one or more locations from the EGC ESP site.[17] Other impacts from a wet cooling system would include occasional fogging, icing, and drift

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9 ER, at 2.2-1.

10 ER, at 2.2-1.

11 ER, at Tables 9.2-6 and 9.2-7; DEIS, at Table 8-4.

12 ER, at 3.6-3.

13 ER, at 5.8-2.

14 ER, at Tables 9.2-6 and 9.2-7; DEIS, at Table 8-4.

15 ER, at 5.3-6.

16 ER, at 5.3-6.

17 ER, at 5.3-6.

droplet deposition.[18] These impacts are expected to be primarily aesthetic in nature.[19] Accordingly, the thermal impacts of the EGC ESP facility would be SMALL.[20]

4. The EGC ESP facility would have a power block structure that could be up to 234 feet high.[21] The cooling tower would have a height of up to 550 feet.[22] The anticipated noise levels from cooling tower operations are expected to be 55 dB at 1,000 feet.[23] These noise levels are consistent with 24 CFR 51, which provides that noise levels are deemed acceptable if the day-night average outside in a residential area is less than 65 dB.[24] As discussed in the previous paragraph (Fact # I.E.3), there may be aesthetic impacts from heat dissipation into the atmosphere.[25] These aesthetic impacts are consistent with the industrial nature of the site.[26] Accordingly, the aesthetic impacts of the EGC ESP Facility would be SMALL.[27]

5. Surface water from Clinton Lake would be used to meet the operational water requirements of the EGC ESP facility.[28] The CPS is the first plant

18 ER, at 5.3-6.

19 ER, at 5.3.-7.

20 ER, at Tables 9.2-6 and 9.2-7; DEIS, at Table 8-4.

21 ER, at 3.1-3.

22 ER, at 3.1-3.

23 ER, at 5.3-11.

24 ER, at 5.3-11.

25 ER, at 5.3-7.

26 ER, at 5.3-7.

27 ER, at Tables 9.2-6 and 9.2-7; DEIS, at Table 8-4.

28 ER, at 5.2-7.

and the only major water user on the lake.[29] Most of the CPS water usage is water drawn from Clinton Lake for condenser cooling. This usage is non-consumptive as it is entirely returned to the lake. The CPS's consumptive use is the result of induced evaporation of water from Clinton Lake caused by the increase in the lake's temperature from the once-through cooling discharge. Operation of the EGC ESP facility would not result in a significant increase in the non-consumptive water use. Wet cooling towers would result in an increase in the consumptive water use. The water use impacts of the EGC ESP facility would be SMALL.[30]

6. The EGC ESP facility would use a new closed cycle cooling water system, and cooling tower blowdown would discharge to the CPS discharge flume to Clinton Lake.[31] The cooling tower discharge from the EGC ESP facility will combine with the cooling water discharge from CPS, increasing the total current discharge by about 10%, from a summer rate of about 566,000 gpm to about 615,000 gpm.[32] The combined discharge flow rates and temperatures from CPS and the EGC ESP facility will remain within the existing limits specified in the National Pollution Discharge Elimination System (NPDES) permit for CPS.[33] The chemical

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29 ER, at 5.2-6.

30 ER, at 5.2-6–5.2-7; DEIS, at 5.5 and Table 8-4.

31 ER, at 5.3-1.

32 ER, at 5.3-3.

33 ER, at 5.3-3.

discharges will also be in compliance with an approved NPDES permit.[34] Lake water temperatures may be marginally increased due to operation of the EGC ESP facility.[35] Accordingly, the impacts on water quality from operation of the EGC ESP facility would be SMALL.[36]

7. Groundwater will not be used as a source of water for the EGC ESP facility.[37] Accordingly, the groundwater use impacts resulting from the operation of the EGC ESP facility would be SMALL.[38]

8. There are no known state- or federally-listed threatened or endangered species at the site or in the site's vicinity, although some rare birds have been sighted in the vicinity.[39] Accordingly, the impact on threatened and endangered species from the EGC ESP facility would be SMALL.[40]

9. The EGC ESP site has already been developed for use by CPS.[41] Accordingly, the impacts to cultural resources from construction and operation of the EGC ESP facility would be SMALL.[42]

10. The work force at the EGC ESP facility is expected to be approximately 3,150 people during construction[43] and 580 people during operation.[44]

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34 ER, at 5.3-4.

35 ER, at 5.2-7.

36 ER, at Tables 9.2-6 and 9.2-7; DEIS, at Table 8-4.

37 ER, at 5.2-7.

38 *See* ER, at 5.2-7 (stating there are no anticipated groundwater use impacts resulting from the operation of the EGC ESP facility).

39 ER, at 2.4-4, 5.3-8.

40 ER, at Tables 9.2-6 and 9.2-7; DEIS, at Table 8-4.

41 ER, at Table 9.2-7.

42 ER, at Tables 9.2-6 and 9.2-7; DEIS, at Table 8-4.

43 ER, at 4.4-2.

Workers would likely live within a 50-mile radius (the region) of the EGC ESP facility and commute to the facility from major nearby metropolitan areas, such as Bloomington-Normal, Champaign-Urbana, Decatur, and Springfield.[45] In the region surrounding the facility, there are about 1.2 million people.[46] Accordingly, socioeconomic impacts from construction and operation of the EGC ESP facility would be SMALL.[47]

11. Radiation and radiological effluents may be transported to and expose living organisms in and around the EGC ESP facility.[48] Exposure from liquid pathways, gaseous pathways, or direct radiation from station operation would be within the limits specified by NRC and EPA regulations.[49] Accordingly, human health impacts from radiological effluents from the EGC ESP facility would be SMALL.[50]

12. Nuclear accidents involving the EGC ESP facility could release substantial quantities of radiation and cause health, environmental, and socioeconomic impacts. The potential radiation exposure to individuals and the population as a whole, the risk of near- and long-term adverse health effects, and the potential environmental, economic, and social

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44 ER, at 5.8-1.

45 ER, at 4.4-2.

46 ER, at 4.4-2–4.4-5, 5.8-3–5.8-5.

47 ER, at Tables 9.2-6 and 9.2-7; *see also* DEIS, at Table 8.4 (stating that socioeconomic benefits would be LARGE).

48 ER, at 5.4-1.

49 ER, at 5.4-1–5.4-4.

50 ER, at Tables 9.2-6 and 9.2-7; DEIS, at Table 8-4.

consequences of an accident, could be severe.[51] However, the probability of such accidents would be low.[52] As a result, the overall impacts of accidents involving a significant release of radioactivity is small given the low probability of occurrence.[53] Accordingly, impacts of accidents from the operation of the EGC ESP facility would be SMALL.[54]

13. Construction of the EGC ESP's power block structure could impact up to 150 acres of terrestrial habitat, potentially displacing various specifies. Additionally, potential new cooling towers would reduce impingement, entrainment, and thermal impacts to aquatic species. Accordingly, ecological impacts from the operation of the EGC ESP facility would be SMALL.[55]

14. The EGC ESP facility would generate, process, store, or release radioactive waste in liquid and gaseous effluents, and in the form of solid waste. Radioactive waste management and effluent control systems will be designed to minimize releases from active reactor operations to values as low as reasonably achievable.[56] Radioactive impacts would be small.[57] Additionally, non-radioactive waste from the EGC ESP facility may include, but are not limited to, boiler blowdown, water and sanitary

51 ER, at 7.2-8.

52 ER, at 7.2-8.

53 ER, at 7.2-8.

54 ER, at Tables 9.2-6 and 9.2-7; DEIS, at 5-77.

55 ER, at Tables 9.2-6 and 9.2-7; DEIS, at Table 8-4.

56 ER, at 3.5-1.

57 RAI Resp., at 32.

treatment wastes, floor and equipment drains, and stormwater runoff.[58] Non-radiological impacts would be negligible.[59] Accordingly, waste management impacts from the operation of the EGC ESP facility would be SMALL.[60]

II. WIND POWER

A. Wind Power Generation Potential

1. 1. Wind power is intermittent.[61] Therefore, wind power by itself cannot be used to generate baseload power, which assumes that a facility is continuously available to produce power, except for refueling, planned, and forced outages.[62]

2. Wind resource maps typically identify areas by wind power class, which range from Class 1 (the lowest) to Class 7 (the highest), at a height of 50 meters at the following average wind speeds:

    a. Class 1: (< 12.5 mph)
    b. Class 2: (12.5–14.3 mph)
    c. Class 3: (14.3–15.7 mph)
    d. Class 3+: (15.5–15.7 mph)
    e. Class 4: (15.7–16.8 mph)
    f. Class 5: (16.8–17.9 mph)
    g. Class 6: (17.9–19.7 mph)
    h. Class 7: (> 19.7 mph)[63]

3. Generally, areas identified as Class 4 and above are regarded as potentially economical for wind energy production with current technology. As a result of advances in technology and the current level of financial

58 ER, at 3.6-1.

59 RAI Resp., at 32.

60 ER, at Tables 9.2-6 and 9.2-7; DEIS, at Table 8-4.

61 RAI Resp., at 5; Intervenors' Ex. 3 at 32, Ex. 14 at 18, and Ex. 15 at 8.

62 RAI Resp., at 8.

incentive support, Class 3+ areas may also be economical for wind development.[64]

4. Illinois has no Class 5 or higher sites.[65] There are scattered areas in central and northern Illinois with a classification of Class 4.[66] The sites are located southeast of Quincy, the greater Bloomington area, north of Peoria, the Matoon area, and between Sterling and Aurora.[67] In Illinois, the total amount of Class 4 lands is approximately 600 square kilometers.[68] EGC does not own or have rights to use this land.[69]

5. There are a number of additional areas within Illinois that are classified as Class 3+.[70] In Illinois, the total amount of Class 3+ lands is approximately 1,200 square kilometers.[71] EGC does not own or have rights to use this land.[72]

6. The total wind potential for Illinois' Class 4 (3,000 MW) and Class 3+ (6,000 MW) areas is about 9,000 MW of installed capacity.[73]

7. At a Class 4 site, the average annual output of a wind power plant is typically about 25% of the installed capacity.[74] The National Electric

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63 Maher & Bagnall Aff. at § V.A.1.

64 RAI Resp., at 5; Intervenors' Ex. 11, at 1.

65 Maher & Bagnall Aff. at § V.A.1.

66 RAI Resp., at 5; Intervenors' Ex. 11, at 1; see also DEIS, at 8-17.

67 RAI Resp., at 5; Intervenors' Ex. 11, at 1.

68 RAI Resp., at 5; Intervenors' Ex. 11, at 1.

69 RAI Resp., at 5.

70 RAI Resp., at 5; Intervenors' Ex. 11, at 1.

71 RAI Resp., at 5; Intervenors' Ex. 11, at 1.

72 RAI Resp., at 5.

73 RAI Resp., at 5; Intervenors' Ex. 11, at 1; DEIS, at 8-17.

Reliability Council credits wind capacity at about 17% in Class 4 areas.[75] More optimistic assessments place the capacity factor for a Class 4 wind facility at about 29%, rising to 35% in 2020 based upon assumed improvements in technology.[76]

8. If it is conservatively assumed that Class 3+ wind areas have the same capacity factor as Class 4 areas, and all of the wind resources in Illinois' Class 3+ and Class 4 sites were developed, based upon the above capacity factors of 17% and 29%, the resulting wind facilities would have an average annual output of 1,530 MWe and 2,610 MWe, respectively.[77]

9. Illinois has one operating wind power project with 50 MW of installed capacity, which produces less than 0.1% (0.0001) of the annual electricity sales, based upon 2002 retail electricity sales levels for Illinois. Illinois has approximately $1.5 billion in proposed new investment in wind power with a total of 3,119 MW of proposed wind power projects. These projects are in various stages of development and review by state and local environmental agencies and transmission system owners/operators, but none of these projects is operating.[78]

B. **Wind Power Costs**

1. Wind power generation has zero fuel costs.[79]

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74 RAI Resp., at 5.

75 RAI Resp., at 5.

76 RAI Resp., at 5; Intervenors' Ex. 3, at 32.

77 Maher & Bagnall Aff. at § V.A.1.

78 Maher & Bagnall Aff. at § V.A.1.

79 Maher & Bagnall Aff. at § V.A.2.

2. The cost of electricity from utility-scale wind power projects was approximately $0.30/kWh in the 1980's.[80]

3. Currently, the cost of generating electricity from wind power ranges from $0.03–$0.06/kWh.[81] The range of costs reflects the differences in wind classes of sites, the size of the wind farm, and the availability of tax credits and other factors.[82] Currently, the cost of generating electricity in Class 5 sites and above is approximately $0.047, in Class 4 sites $0.054, and $0.064 in Class 3+ sites.[83] The cost of electricity from wind facilities at sites similar to those available in Illinois is currently about $0.057/kWh.[84]

4. There have been improvements in wind turbine technology over the years.[85] In recent years, the largest commercially available wind turbines were between 1 MW and 1.6 MW.[86] Most wind turbines currently being installed in the United States have a peak capacity of approximately 1.5 to 1.6 MW.[87] General Electric Wind Energy is currently producing 2.3–2.7 MW land-based turbines and 3.6 MW turbines designs for offshore use.[88] These large turbines are not readily available for large-scale commercial

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80 Maher & Bagnall Aff. at § V.A.2; Intervenors' Ex. 15 at 6.

81 RAI Resp., at 6; Intervenors' Ex. 3 at 26.

82 Maher & Bagnall Aff. at § V.A.2.

83 Maher & Bagnall Aff. at § V.A.2; Intervenors' Ex. 3 at 43.

84 RAI Resp., at 17.

85 RAI Resp., at 6.

86 Maher & Bagnall Aff. at § V.A.2.

87 Maher & Bagnall Aff. at § V.A.2.

88 Maher & Bagnall Aff. at § V.A.2; Intervenors' Ex. 13, at 1.

use.[89] Clipper Wind Power has announced the groundbreaking for installation of a commercial prototype of its 2.5 MW wind turbine.[90] This turbine is not commercially available in large numbers.[91]

5. By 2020, wind power generating costs are projected by some environmental groups to fall to $0.03–$0.04/kWh.[92]

6. Direct public sector support programs have contributed to reduced capital and operating costs for wind power. For example, the Federal Production Tax Credit (PTC) has been renewed through the year 2005, which provides a tax credit of $0.018 cents per kWh for wind facilities placed in service after December 31, 1993 and before January 1, 2006. Further, a five-year depreciation schedule is available for renewable energy systems under the Economic Recovery Tax Act of 1981.[93]

7. Several states have implemented various policies providing incentives to wind power generation. As of August 2004, Illinois enacted legislation creating the Illinois Resource Development and Energy Security Act. The legislation adopted a statewide renewable energy goal of at least 5% of total energy by 2010, and at least 15% by 2020. Finally, Illinois has also established Public Benefits Funds (PBFs) to fund renewable energy. Typically, a small per-kWh charge—called a System Benefit Charge—is added to residents' electricity bills to raise the needed funds. In Illinois,

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89 Maher & Bagnall Aff. at § V.A.2.

90 Maher & Bagnall Aff. at § V.A.2.

91 Maher & Bagnall Aff. at § V.A.2.

92 RAI Resp., at 6; Intervenors' Ex. 3 at 43.

93 Maher & Bagnall Aff. at § V.A.2.

wind projects greater than 10 MW in size are eligible to have up to 10% of project costs paid for out of the PBF.

8. There are areas in the Upper Midwest with the potential to produce economical generation of wind power. For example, North and South Dakota, as well as parts of Iowa, have some areas designated as Class 6 and above, and other states have Class 5 sites.[94]

9. Development of wind resources in the Upper Midwest at the scale of the proposed EGC ESP facility would need to address the availability of long-distance transmission lines. The transmission system infrastructure to support transmission of large bulk power from these areas in the Upper Midwest is currently not available and investment in new long-distance transmission infrastructure is not forthcoming. Any new long-distance transmission development could take at least 10 years from proposal through permitting and construction.[95]

10. The cost of any new transmission capacity would be high. The additional costs to expand the transmission system to accommodate large-scale wind farms are not reflected in the cost of wind power energy discussed earlier.[96]

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94 Maher & Bagnall Aff. at § V.A.2; RAI Resp. at 5.

95 Maher & Bagnall Aff. at § V.A.2; *see also* Intervenors' Ex. 3 at 29, Ex. 14 at 18, and Ex. 15 at 9.

96 Maher & Bagnall Aff. at § V.A.2; *see also* Intervenors' Ex. 12 at 4–5.

11. There are voltage and stability issues associated with transmission of power in the Upper Midwest states.[97] Development of large wind farms in the Upper Midwest would aggravate these voltage and stability issues.[98]

12. Some authors have postulated that electricity generated in wind facilities in areas far removed from loads could be converted to hydrogen by electrolysis, and the hydrogen could be transmitted by pipeline to population centers, where it could be used to produce electricity in fuel cells. Long-distance pipeline transmission of hydrogen is not commercially available. Additionally, there are no large-scale electrolysis plants available for this purpose.[99]

C. **Wind Power Environmental Impacts**

1. Wind generation produces no air pollution, greenhouse gases, or solid or liquid waste.[100] Wind power does not use coolant water or have thermal discharges.[101] Therefore, the impacts on air and water quality from wind power are SMALL.[102]

2. The land between wind turbines is largely available for other uses that do not impact the turbine, such as agricultural use.[103] For illustrative

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97 RAI Resp., at 7.

98 Maher & Bagnall Aff. at § V.A.2.

99 Maher & Bagnall Aff. at § V.A.2.

100 Maher & Bagnall Aff. at § V.A.3; Intervenors' Ex. 3 at 12, Ex. 14 at 15, and Ex. 15 at 14–15.

101 Maher & Bagnall Aff. at § V.A.3.

102 RAI Resp., at 27.

103 Maher & Bagnall Aff. at § V.A.3; DEIS, at 8-17; Intervenors' Ex. 12 at 1, Ex. 14 at 15.

purposes, a 2 MW turbine requires about a quarter of an acre of dedicated land for the actual placement of the wind turbine. [104]

3. In Illinois, if all of the Class 3+ and Class 4 sites were developed, the sites would occupy about 1,800 km^2 of land. Using 2 MW turbines, with each turbine occupying one-quarter acre, the wind facilities would have an installed capacity of 9,000 MW and would utilize 1,125 acres for the placement of the wind turbines alone.[105] Assuming a capacity factor of 17%, this corresponds to approximately 0.73 acres/MWe.[106] If an optimistic capacity factor of 29% is used, this project would occupy 0.43 acres/MWe.[107] Land impacts for wind projects would be SMALL to LARGE depending upon the amount of wind power installed.[108]

4. Wind turbines can cause deaths to birds due to collisions.[109] Studies performed at sites around the U.S. measure one or two bird deaths per turbine per year.[110] Bird deaths due to wind generation are a small fraction of those caused by other human activities.[111] Accordingly, impacts from avian collisions for wind projects would be SMALL.[112]

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104 RAI Resp., at 5; *see also* Intervenors' Ex. 15 at 16.

105 RAI Resp., at 5–6.

106 Maher & Bagnall Aff. at § V.A.3.

107 Maher & Bagnall Aff. at § V.A.3.

108 RAI Resp., at 26; DEIS, at 8-17.

109 RAI Resp., at 8; DEIS, at 8-17; *see also* Intervenors' Ex. 14 at 17.

110 Maher & Bagnall Aff. at § V.A.3; Intervenors' Ex. 14 at 17.

111 Maher & Bagnall Aff. at § V.A.3; *see also* DEIS, at 8-17; Intervenors' Ex. 3 at 28, Ex. 14 at 17, and Ex. 15 at 15.

112 RAI Resp., at 28; *see also* Intervenors' Ex. 3 at 28.

5. Wind turbines produce noise.[113] Technological advancements continue to lessen noise problems associated with wind turbines.[114] Modern wind turbines are less noisy than their predecessors. The level of noise drops with increased distances.[115] Noise impacts for wind projects could be SMALL to LARGE depending on the size and placement of the wind project.[116] However, if the wind facilities were remotely located in order to mitigate the noise impacts, the impacts would be SMALL.[117]

6. Due to their size, wind facilities may have aesthetic impacts.[118] Nationwide, many communities have opposed the placement of nearby wind projects.[119] Aesthetic impacts for wind projects could be SMALL to LARGE depending on the size and placement of the wind project.[120] However, if the wind facilities were remotely located in order to mitigate the aesthetic impacts, the impacts would be SMALL.[121]

III. Solar Power

A. Solar Power Generation Potential

1. Solar power is intermittent as it is dependent on the availability and strength of sunlight.[122] Solar is not available to produce power at night or

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113 RAI Resp., at 8; Intervenors' Ex. 3 at 28.

114 Maher & Bagnall Aff. at § V.A.3; Intervenors' Ex. 3 at 28, Ex. 15 at 16.

115 Maher & Bagnall Aff. at § V.A.3.

116 RAI Resp., at 32.

117 Maher & Bagnall Aff. at § V.A.3.

118 RAI Resp., at 8.

119 Maher & Bagnall Aff. at § V.A.3; Intervenors' Ex. 3 at 28, Ex. 14 at 17.

120 RAI Resp., at 32.

121 Maher & Bagnall Aff. at § V.A.3.

122 RAI Resp., at 9; *see also* Intervenors' Ex. 3 at ES-10, 50.

on overcast days.[123] Therefore, solar power, by itself, cannot be used to generate baseload power, which assumes that a facility is continuously available to produce power, except for refueling, planned, and forced outages.[124]

2. In Illinois, solar energy varies but is approximately 4 kWh/m^2/day on average. The southwestern part of the United States receives about twice as much solar energy as Illinois.[125]

3. Solar technologies can be divided into two groups. The first group—concentrating solar power systems—concentrates the sun's energy to drive a heat engine which runs a turbine to produce electricity. The second group is photovoltaics (PV), which directly converts solar energy into electricity.[126]

4. There are no commercial solar concentrating systems in Illinois. There are about 100 distributed solar electric installations in Illinois producing 2,000 MWh per year or about 228 average kw statewide. Most of these are located on buildings as distributed generation.[127]

B. **Concentrating Solar Power Systems**

1. There are three kinds of concentrating solar power systems:

   a. a. In a trough system, the sun's energy is concentrated by trough-shaped reflectors onto a receiver pipe running along the inside of

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123 Maher & Bagnall Aff. at § V.B.

124 RAI Resp., at 9.

125 RAI Resp., at 9, 21; Maher & Bagnall Aff. at § V.B.1; DEIS, at 8-18.

126 RAI Resp., at 11.

127 Maher & Bagnall Aff. at § V.B.

the curved surface.[128] This energy heats oil flowing through the pipe and the heat energy is then used to generate electricity in a conventional steam turbine generator.[129] Individual trough systems generate about 80 MW while experimental trough systems in California can generate approximately 300 MW.[130] Current storage capacity at trough plants is about 25%.[131] Currently, all trough plants are "hybrids" meaning they use fossil-fueled generation to supplement the solar output during periods of low solar radiation.[132] The technology is still in the development stage and is not commercially available.[133]

b. A dish/engine system is a stand-alone unit composed of a collector, a receiver, and an engine.[134] The dish-shaped surface collects and concentrates the sun's energy onto a receiver that absorbs the energy and transfers it to the engine's working fluid.[135] The engine converts the heat by compressing the working fluid when it is cold, heating the compressed working fluid, and then expanding it through a turbine or with a piston to produce work.[136] These

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128 RAI Resp., at 10.

129 RAI Resp., at 10.

130 RAI Resp., at 10.

131 RAI Resp., at 10.

132 RAI Resp., at 10.

133 Maher & Bagnall Aff. at § V.B.1.

134 RAI Resp., at 10.

135 RAI Resp., at 10.

136 RAI Resp., at 10.

systems are not commercially available yet and the technology is still in the development stage. [137]

c. In a power tower system, the sun's energy is concentrated by a field of mirrors onto a receiver located on top of a tower.[138] The solar energy then heats molten salt flowing through the receiver, and the salt's heat energy is used to generate electricity in a conventional steam turbine generator.[139] This molten salt retains heat efficiently, allowing it to be stored for hours or days before it loses its capacity to generate electricity.[140] Before the project was discontinued, a demonstration power tower located in the Mojave Desert, in California, generated about 10 MW of electricity.[141] Power tower systems can operate at an annual capacity factor of 65%.[142] The technology is not commercially available and is still in the development stage. [143]

2. Currently, concentrating solar power systems cost \$0.09–\$0.12/kWh.[144] Future advances in technology are expected to decrease the cost of concentrating solar power generation to \$0.04–\$0.05/kWh in the next few

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137 Maher & Bagnall Aff. at § V.B.1.

138 RAI Resp., at 10.

139 RAI Resp., at 10.

140 RAI Resp., at 10-11.

141 RAI Resp., at 11.

142 RAI Resp., at 11.

143 Maher & Bagnall Aff. at § V.B.1.

144 RAI Resp., at 11.

decades.[145] These costs are for southwestern United States.[146] Since Illinois on average receives about half of the solar energy as the southwestern United States, the cost of electricity from such facilities, if built in Illinois, would be about twice as high.[147]

C. PV Cells

1. A single PV cell measures about 4 inches on each side and produces about 1 watt of power.[148] A PV module consists of about forty or so PV cells.[149] Ten modules can be arranged into PV "arrays" which measure up to several meters on a side.[150] Hundreds of arrays can be interconnected to form a single, large PV system for large electric generation.[151]

2. PV cell conversion efficiencies are currently about 15%.[152] The maximum conversion efficiency in a laboratory setting is about 25%.[153]

3. PV's capital costs are $5–$20 per watt.[154] This wide range in cost is due to site specific factors, such as variations in the cost of land, site considerations, orientation, and structures.[155] The total cost of generating electricity from PV is $0.20–$0.50/kWh in the southwestern United States.

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145 RAI Resp., at 11.

146 Maher & Bagnall Aff. at §§ III, V.B.1.

147 Maher & Bagnall Aff. at §§ III, V.B.1.

148 RAI Resp., at 11.

149 RAI Resp., at 11.

150 RAI Resp., at 11.

151 RAI Resp., at 11–12.

152 RAI Resp., at 12.

153 Maher & Bagnall Aff. at § V.B.2; *see also* DEIS, at 8-18.

154 RAI Resp., at 12; *see also* Intervenors' Ex. 3 at 42.

155 Maher & Bagnall Aff. at § V.B.2.

The cost of generating electricity from PV in Illinois would be approximately twice as high because it receives about 50% less solar radiation.[156]

4. Improvements in production and technology could decrease the cost of centralized PV systems to \$0.15–\$0.20/kWh in the southwestern U.S. by the year 2020.[157] The costs in Illinois would be about twice that amount.[158]

D. **Solar Environmental Impacts**

1. During operation, PV and solar thermal generation produce no air pollution, greenhouse gases, solid waste, or noise, and require no transportable fuels.[159] Accordingly, the impacts on air and water quality from solar power are SMALL. [160]

2. Lands used for solar facilities are not available for other uses such as agriculture.[161] In order for PV cells to generate an amount of electricity equivalent to that produced by the EGC ESP facility, the PV cells would require tens of square kilometers.[162] Land use impacts could range from SMALL to LARGE depending on the size of the solar project.[163]

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156 Maher & Bagnall Aff. at § V.B.2; *see also* Intervenors' Ex. 3 at 40, 42–43.

157 Maher & Bagnall Aff. at § V.B.2.

158 Maher & Bagnall Aff. at § V.B.2.

159 Maher & Bagnall Aff. at § V.B.3; Intervenors' Ex. 3, at 39.

160 RAI Resp., at 27.

161 RAI Resp., at 13.

162 RAI Resp., at 12; Maher & Bagnall Aff. at § V.B.3; *see also* DEIS, at 8-18.

163 RAI Resp., at 13, 26; *see also* DEIS at 8-18.

3. Distributed solar PV panels (*e.g.*, PV panels on tops of buildings) are not typically employed by independent power producers. EGC does not have rights to place solar panels on tops of buildings that it does not own.[164]

4. Depending on the solar technology, there may be thermal discharge impacts from concentrating solar power systems, which operate steam turbines and use water to condense the steam.[165] The water then discharges its heat, either directly to water bodies or to cooling towers.[166] The environmental impacts from these heat discharges are expected to be SMALL. [167]

5. There are human health risks and environmental impacts associated with the manufacture, use, and disposal of solar power technologies.[168] Chemicals used in the manufacture of PV cells include cadmium and lead.[169] Human health risks arise since there is a risk of exposure to heavy metals such as selenium and cadmium during use and disposal.[170] There is a risk that used PV cells that are discarded in landfills could leach cadmium, mercury, and lead into the environment in the long term.[171] Further, lead-acid batteries are used in some solar technology systems, and

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164 Maher & Bagnall Aff. at § V.B.3.

165 Maher & Bagnall Aff. at § V.B.3.

166 Maher & Bagnall Aff. at § V.B.3.

167 RAI Resp., at 13.

168 RAI Resp., at 13.

169 RAI Resp., at 13.

170 RAI Resp., at 13.

171 RAI Resp., at 13.

there is a risk that discarded batteries could also leach contaminants in landfills.[172] The impact of these potential risks is SMALL. [173]

IV. **Combination of Alternatives**

A. **Combinations of Wind and Solar Power**

1. Combinations of wind power and solar power alone could not be relied upon as a dependable source of baseload power. There will be many occasions when the wind statewide is insufficient to generate any electricity for extended periods of time. Also, there will be many occasions when the sun is not shining and there is insufficient wind to generate power. During such periods, the combination of the wind and solar power facilities would produce little or no electricity, and would need to be supplemented by energy storage systems or fossil-fueled facilities to produce dependable baseload power.[174]

B. **Combinations of Wind and Solar Power with Energy Storage Systems**

1. Wind and solar facilities could be used in combination with storage systems to produce baseload power. By storing the power produced from wind and/or solar facilities and releasing it when the wind and solar facilities are not generating power, energy storage in combination with the wind and/or solar facilities would be able to generate electricity continuously.[175]

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172. RAI Resp., at 13.

173 RAI Resp., at 13, 30, 32.

174 Maher & Bagnall Aff. at § V.C.1.

175 Maher & Bagnall Aff. at § V.C.2.

2. The storage of one day's output at 2,180 MW is beyond any demonstration projects using batteries, compressed air, hydrogen, or other storage mechanism. The cost of such systems, even if available, would be prohibitive. Adding the significant cost of storage systems to the cost of wind or solar facilities would render the total cost non-competitive.[176]

3. Solar storage systems are not available on the scale of the EGC ESP facility or are still in the demonstration stage.[177]

4. In the northwestern United States, existing hydropower reservoirs are used to levelize wind generation. This approach is not available in Illinois to store large amounts of energy.[178]

5. Pumped storage is not available in Illinois for storage of large amounts of energy, and the costs of development of such facilities would be prohibitive.[179]

C. Combinations of Wind and Solar Power with Coal or Natural Gas-Fired Facilities Could Generate Baseload Power

1. Generation Potential

a. Wind or solar power combined with a fossil-fueled facility, such as a natural gas-fired or coal facility, has the potential to produce an amount of baseload power equivalent to that of the EGC ESP facility.[180] The fossil-fueled portion of the combination can produce the needed power during those periods when the sun is not

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176 Maher & Bagnall Aff. at § V.C.2.

177 Maher & Bagnall Aff. at § V.C.2.

178 Maher & Bagnall Aff. at § V.C.2.

179 Maher & Bagnall Aff. at § V.C.2.

shining or the wind is not blowing.[181] The coal or natural gas-fired generation would be displaced when the wind and/solar resource is producing power.[182]

b. It would be necessary to construct coal or natural gas-fired facilities that have a peak capacity of 2,180 MW in combination with wind and/or solar facilities to produce baseload power equivalent to the EGC ESP facility. Whenever the wind/solar generation is less than 2,180 MW, the coal or natural gas-fired generation would need to run to bring the total generation output to 2,180 MW.[183]

2. **Cost of Combinations**

a. The estimated cost of generating electricity from a natural gas-fired facility alone is currently $0.047/kWh; and from a coal facility alone is currently $0.049/kWh.[184]

b. The cost of electricity production (on a per kWh basis) from a coal or natural gas-fired facility in combination with wind and/or solar facilities would increase relative to the cost of baseload coal or natural gas-fired facilities because the capital costs and operating

180 RAI Resp., at 14.

181 Maher & Bagnall Aff. at § V.C.3.a.

182 Maher & Bagnall Aff. at § V.C.3.a.

183 Maher & Bagnall Aff. at § V.C.3.a.

184 RAI Resp., at 17.

costs of either type of facility would be spread across fewer kWh.[185]

c. The cost of electricity from a combination of coal/natural gas facilities and wind/solar facilities would exceed the cost of electricity from a new nuclear facility.[186]

D. **Environmental Impacts**

1. Coal and natural gas-fired generation have the following environmental impacts:

a. Air Quality Impact—To produce baseload power equivalent to the EGC ESP facility, a coal-fired generation facility using concentrated coal technologies would generate: 8,127 tons of Sulfur Oxide/year, 2,054 tons of Nitrous Oxide/year, 2,118 tons of Carbon Monoxide/year, 292 tons of Particulate Matter/year, and 67 tons of Particulate Matter^{10}/year.[187] "Clean coal" power plant technology decreases the air pollution impacts associated with burning coal for power. However, the environmental impacts of "clean coal" technologies are greater than the impacts from a natural gas-fired facility.[188] The air quality impacts from a coal-fired plant would be MODERATE to LARGE.[189] An equivalent-sized natural gas-fired facility would generate: 177 tons of

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185 RAI Resp., at 17–18; Maher & Bagnall Aff. at § V.C.3.b.

186 RAI Resp., at 17–18; Maher & Bagnall Aff. at § V.C.3.b.

187 RAI Resp., at 27; ER, at 9.2-13; DEIS, at Table 8-1.

188 RAI Resp., at 15.

189 RAI Resp., at 15; ER, at Table 9.2-6; DEIS at Table 8-1.

SO_x/year, 568 tons of NO_x/year, 120 tons of CO/year, and 99 tons of particulate matter[10]/year.[190] The air quality impacts from a natural gas-fired plant would be SMALL to MODERATE. [191]

b. Water Quality Impact—The water quality impact from both a coal-fired and natural gas-fired generation would be SMALL.[192]

c. Land Use and Ecological Resources Impacts—The construction of a coal-fired plant's power block and storage areas for ash/sludge disposal would impact approximately 300 acres of terrestrial habitat. The construction of a natural gas-fired plant's power block would impact up to 150 acres of terrestrial habitat. Accordingly, the impact from either a natural gas-fired or coal-fired plant on land use and ecological resources would be SMALL.[193]

d. Threatened and Endangered Species Impact—No resident threatened and endangered species are known to occur at the ESP site or along transmission corridors.[194] Accordingly, the impact on

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190 RAI Resp., at 15; ER, at 9.2-16.

191 RAI Resp., at 15; ER, at Table 9.2-6. The DEIS indicates that the air quality impacts from a natural gas-fired plant would be SMALL to MODERATE. DEIS, at Table 8-2. In contrast, the ER indicates that the impacts would be MODERATE. To be conservative, the above statement adopts the DEIS's conclusions.

192 RAI Resp., at 15; ER, at Table 9.2-6. This conclusion is conservative. The DEIS indicates that the water quality impact from both a coal-fired and natural-gas fired generation would be SMALL to LARGE. DEIS, at Tables 8-1 and 8-2.

193 RAI Resp., at 28. This conclusion is conservative. The DEIS indicates that the ecological resources impacts from a coal-fired plant would be MODERATE to LARGE and SMALL TO MODERATE for a natural gas-fired plant. The DEIS also indicates that the land use impacts associated with a coal-fired plant would be MODERATE. DEIS, at Tables 8-1 and 8-2.

194 RAI Resp., at 29.

threatened and endangered species relative to natural gas-fired and coal-fired generation at the ESP site would be SMALL.[195]

e. Cultural Resource Impacts—The ESP site was previously disturbed.[196] Accordingly, the impact of coal-fired or natural gas-fired generation on cultural resources would be SMALL.[197]

f. Socioeconomic Impact—Approximately 250 expected employees would be needed to generate electricity from a coal-fired facility.[198] It is expected that a natural gas-fired facility would require anywhere between 40–150 employees.[199] Workers would likely live within a 50-mile radius and commute to the facility from major nearby metropolitan areas, such as Bloomington-Normal, Champaign-Urbana, Decatur, and Springfield. In the region surrounding the facility, there are about 1.2 million people.[200] Accordingly, the socioeconomic impacts from either type of facility would be SMALL.[201]

2. There is an inverse relationship between the potential output of the wind/solar portion of the combination alternative and the environmental impacts associated with operation of the coal or natural gas-fired portion

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195 RAI Resp., at 29; ER, at Table 9.2-6.

196 RAI Resp., at 33.

197 RAI Resp., at 33; ER, at Table 9.2-6; DEIS at Tables 8.1 and 8.2.

198 ER, at 9.2-15.

199 ER, at 9.2-17.

200 ER, at 4.4-2–4.4-5, 5.8-3–5.8-5.

201 ER, at Table 9.2-6; RAI Resp., at 31. As the DEIS indicates, the socioeconomic benefits from either type of facility would be LARGE. DEIS, at Tables 8.1 and 8.2.

of the combination alternative—*i.e.*, the greater the output of the wind and/or solar portion of the combination alternative, the lower the environmental impacts associated with the operation of coal or natural gas-fired portion of the combination alternative.[202]

3. If the wind/solar facilities have a peak capacity less than the capacity of the EGC ESP facility, the construction and operational environmental impacts of the wind/solar facilities would be reduced relative to such facilities that have a capacity equivalent to the EGC ESP facility.[203]

4. The greater use of wind/solar facilities would reduce the fuel and fuel-burning operational impacts (*i.e.*, gaseous emissions) from a coal or natural gas-fired facility, since the wind/solar facilities would supplant the coal or natural gas-fired facility when the wind/solar facilities operate.[204]

5. The air quality impacts of a combination of natural gas/coal facilities and wind/solar facilities would likely be MODERATE. The land impacts of a combination of natural gas/coal facilities and an appreciable amount of wind/solar facilities would likely be MODERATE. Even if the impacts could be reduced to SMALL, the combination would not be environmentally preferable to a nuclear facility.[205]

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202 RAI Resp., at 17.

203 Maher & Bagnall Aff. at § V.C.3.c.

204 Maher & Bagnall Aff. at § V.C.3.c.

205 Maher & Bagnall Aff. at § V.C.3.c. The DEIS, Table 8-3, states that a combination of alternatives would have a SMALL to MODERATE impact on air quality, a SMALL impact on land use, a SMALL to MODERATE impact on ecology, a SMALL to LARGE impact on water use and quality, and a MODERATE impact on aesthetics. Therefore, the postulation above that the impacts could be SMALL is conservative.

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	Docket No. 52-007-ESP
Exelon Generation Company, LLC	)	
	)	ASLBP No. 04-821-01-ESP
(Early Site Permit for Clinton ESP Site)	)	

JOINT AFFIDAVIT OF WILLIAM D. MAHER AND CURTIS L. BAGNALL

I. PERSONAL QUALIFICATIONS

William D. Maher, being duly sworn, states as follows:

I am currently an Environmental Lead working as a contractor for Exelon Generation Company, LLC (EGC). I have been in this position since 1999. In this position, I am responsible for developing environmental reports for license renewal and early site permitting. Prior to that, I was employed by Sequoia Consulting Group as an Engineering Consultant. I have a degree in nuclear engineering. A copy of my resume is attached to this affidavit as Enclosure 1. As part of my duties for EGC, I was responsible for supervising preparation of the *Environmental Report for the Exelon Generation Company, LLC Early Site Permit* (ER). The ER is true and correct to the best of my knowledge, information, and belief.

With respect to this joint affidavit, I prepared those sections that (i) provide an overview of EGC's response to the Nuclear Regulatory Commission (NRC) Staff's request for additional information (RAI) E.9.2-1; (ii) provide additional information on the cost of the EGC Early Site Permit facility (EGC ESP facility); (iii) assess the environmental impacts of wind and solar power, and a combination of these alternatives with energy storage and coal and/or natural gas-fired generation; (iv) compare the information in the NRC Staff's *Draft Environmental Impact Statement for an Early Site Permit at the Clinton Site*, (DEIS) NUREG-1815 (February 2005), Chapter 8.2.5, "Other Alternatives" with the information in the RAI Response; and (v) demonstrate that the information contained in Intervenors' exhibits and disclosures is consistent with the information in the RAI Response. To more readily identify these sections, I have included my name within brackets (*i.e.*, [W. Maher]) immediately preceding those sections I prepared.

Curtis L. Bagnall, being duly sworn, states as follows:

I am currently Vice President and Project Manager for CH2M Hill. I have been employed by CH2M Hill since 1972. My responsibilities include planning, analysis, design, and construction related to electric utility operations, power supply, transmission, distribution financing, and operations. My experience also includes evaluating other energy projects, including wind and solar. I have degrees in electrical engineering and business administration. A copy of my resume is attached to this affidavit as Enclosure 2.

With respect to this joint affidavit, I prepared those sections that evaluate the cost, potential, and availability of wind and solar power, and a combination of these alternatives with energy storage and coal and natural gas-fired generation. To more readily identify these sections, I have included my name within brackets (*i.e.*, [C. Bagnall]) immediately preceding those sections I prepared.

II. PURPOSE OF THE AFFIDAVIT

The purpose of this affidavit is to:

- Provide an overview of EGC's response to RAI E.9.2-1 related to Contention 3.1 (the RAI Response was attached to a letter dated September 23, 2004 from Marilyn C. Kray (EGC) to the NRC);

- Provide additional information regarding the cost of a new nuclear plant that demonstrates wind and solar power and combinations thereof with coal and/or natural gas-fired generation are not economically preferable to the proposed EGC ESP facility;

- Provide additional information on wind and solar power, and a combination of these alternatives with energy storage and coal and/or natural gas-fired generation to address certain information provided in the Intervenors' Exhibits and documents cited in their discovery disclosures;

- Demonstrate that the information in the DEIS on wind and solar power is consistent with the information in the RAI Response; and

- Demonstrate that the information contained in the Intervenors' Exhibits in support of Contention 3.1 and the documents identified by Intervenors in their discovery disclosures is consistent with the information in the RAI Response.

III. OVERVIEW OF EGC'S RAI RESPONSE

[W. Maher] Contention 3.1 alleges that the ER is premised "on several material legal and factual flaws that lead it to improperly reject the better, lower-cost, safer, and environmentally preferable wind power and solar power alternatives, and fails to address adequately a mix of these alternatives along with the gas-fired generation and 'clean coal' resource alternatives." Following admission of Contention 3.1 by the Licensing Board, the NRC Staff issued to EGC RAI E9.2-1 regarding Contention 3.1. In response to this RAI, EGC identified revisions to the analysis of wind and solar power in Chapter 9 of the ER for the EGC ESP facility. The RAI Response is based upon information current at the time of submission, including references to 24 industry and governmental reports issued between 2001 and 2004. The RAI Response also refers to documents provided or cited by Intervenors in support of Contention 3.1, and documents identified by the Intervenors as part of their discovery disclosures pursuant to 10 CFR § 2.336.

The RAI Response includes a detailed analysis of wind power, solar power, and combinations involving wind and solar power with natural gas and coal facilities. EGC plans to revise the ER in the near future to include the information in the RAI Response and other information that is unrelated to Contention 3.1. EGC's Response to RAI E.9.2-1 is attached to this affidavit as Enclosure 3.

The RAI Response was prepared under my supervision and control. The information in the RAI Response is true and correct to the best of my knowledge, information, and belief. I would, however, like to make the following clarifications.

- Page 13 of the RAI Response indicates that the land required for the solar generating technologies ranges from 3 to 12 acres/MWe. This figure should be 2.5 to 12 acres/MWe, which is consistent with similar data provided on page 12 of the RAI Response.
- Page 15 of the RAI Response (section 9.2.3.3.1) states that coal-fired generation is used for the purposes of the economic comparison of combinations of alternatives (*i.e.*, wind/solar and coal and/or natural gas-fired generation), whereas page 17 of the RAI Response (section 9.2.3.3.3) discusses the impacts of using natural gas-fired generation in combination with wind/solar power and concludes that the costs of a combination alternative would not be competitive with the EGC ESP facility. As a matter of clarification, in performing the analysis for developing section 9.2.3.3.3, EGC considered the cost of generating electricity from either a natural gas-fired or coal-fired plant in a combination with wind/solar facilities, and found roughly equivalent results. I discuss this in more detail later in this affidavit.
- There is a typographical error which resulted in the omission of several lines in the first bullet on page 17 of the RAI Response. The first bullet should state as follows (the underlined text indicates the lines that were inadvertently omitted in the RAI Response):

> All of the environmental impacts of a new nuclear plant at the EGC ESP Site and all of the impacts from a gas-fired plant are small, except for air quality impacts from a gas-fired facility (which are moderate). Use of wind and/or solar facilities in combination with a gas-fired facility <u>would reduce the air quality impacts from the gas-fired facility.</u>

However, at best, those impacts would be small, and therefore would be equivalent to the air quality impacts from a nuclear facility.

- Page 17 of the RAI Response states that the United States Department of Energy (DOE) has estimated the cost of electricity from solar power at $0.04–$0.05 per kWh. Page 11 of the RAI Response indicates this estimate is for concentrating solar power facilities that may be built in the next few decades. The costs of existing concentrating solar power facilities are about $0.09–$0.12 per kWh. Additionally, these estimated costs are for facilities located in the southwestern United States. Since Illinois on average only receives about half of the solar energy as the southwestern United States, I estimate that the cost of electricity from such future facilities if built in Illinois would be about twice as high.
- Page 27 of the RAI Response indicates that the natural gas-fired alternative would produce 117 tons of SO_x/year. This figure should be 177 tons of SO_x/year, which is consistent with similar data provided on Page 9.2-16 of the ER.

IV. COST OF THE EGC ESP FACILITY

[W. Maher] EGC has not selected a particular design to construct and operate at the Clinton ESP site. Therefore, there are no specific cost estimates for the EGC ESP facility. However, the Electric Power Research Institute (EPRI) has issued a Utility Requirements Document (URD), which consists of a comprehensive set of requirements (including cost requirements) for future light water reactors (LWRs). The URD states that one of the requirements for utilities to purchase new nuclear plants is that their median busbar costs be "sufficiently less than 43 mills/kWh" ($0.043/kWh) in 1994 dollars (about $0.055 per kWh in 2004 dollars).

Page 17 of the RAI Response estimates that the projected total cost of electricity associated with a new nuclear facility is in the range of $0.031–$0.046 per kWh. These cost estimates are based upon a 2004 study, *The Economic Future of Nuclear Power*, commissioned by the DOE and conducted at the University of Chicago, which evaluates the economic factors affecting the future of nuclear power in the United States. The study reviews plant deployment during the next decade and the competitiveness of the next series of nuclear plants. Further, it reviews and evaluates alternative sources of information bearing on the nuclear power industry, and presents scenarios encompassing a reasonable range of future possibilities. It is important to note that the study's results are based upon a wide range of assumptions: *i.e.*, whether capital costs are based upon a first new nuclear plant or the last plant of the same design, discount rates, and varying construction time periods. Its economic findings are as follows:

- Capital cost is the single most important factor determining the economic competitiveness of nuclear energy.
- First-of-a-kind engineering (FOAKE) costs for new nuclear designs would increase capital costs.
- The risk premium paid to bond and equity holders for financing new nuclear plants is an influential factor in the economic competitiveness of nuclear energy. A 3% risk premium on bonds and equity is estimated to be appropriate for the first few new plants.
- Without federal financial policy assistance and including FOAKE costs, new nuclear plants coming on line in the next decade are projected to have a levelized cost of electricity (LCOE) of $0.047–$0.071 per kWh.
- With assistance in the form of loan guarantees, accelerated depreciation, investment tax credits, or production tax credits, new nuclear plants would have LCOEs of $0.032–$0.05 per kWh.
- Relative to deploying the next series of plants, with the benefit of the experience from the first new plants, LCOEs are expected to fall in the range of $0.031–$0.046 per kWh.

As indicated above, the University of Chicago Study provides cost estimates for a variety of different nuclear power plants. For purposes of estimating a cost for the EGC ESP facility for this proceeding, I believe that it is reasonable to use Westinghouse's AP1000 design as a point of comparison. The AP1000 is a passive LWR, and therefore utilizes significantly fewer safety-related systems than existing operating reactors. The AP1000 is the most recent design approved by the NRC Staff, thereby providing greater certainty to estimates for the cost of construction of an AP1000 than other advanced reactors. Although the cost estimates for some other advanced reactors (*e.g.*, gas-cooled reactors) are less than the estimates for the AP1000, those designs have not yet been approved by the NRC and there is more uncertainty regarding their costs.

As stated on page 3-13 of the University of Chicago study, the capital costs for the AP1000, without first-of-a-kind engineering (FOAKE) costs, have been estimated by Westinghouse to be $1,100 to $1,200 per kW. Similarly, according to a recent *Nucleonics Week* article, General Electric's current estimate for the overnight capital cost of its Economic and Simplified Boiling Water Reactor (ESBWR) design is in the range of $1,190 to $1,250 per kW. Using the Westinghouse cost estimate, and assuming a five-year construction period and an 85% capacity factor, Table 5-3 of the University of Chicago study estimates a levelized cost of electricity (LCOE) of $47 per MWh ($0.047 per kWh), in 2003 dollars. The LCOE is the price at the busbar needed to cover operating expense plus annualized capital costs. The study then assumes that inclusion of FOAKE costs into the costs for the first plant would increase the capital costs by 30% to about $1,500 per kW, resulting in a LCOE of $54 per MWh ($0.054 per kWh) for a five-year construction period. The University of Chicago study estimates that these costs could rise to $53 per MWh ($0.053 per kWh) and $62 per MWh ($0.062 per kWh), respectively for plants without FOAKE costs and for plants with FOAKE costs, assuming a seven-year construction duration. However, this seven-year construction duration reflects past construction experience in the United States, which does not account for the simplified design for the AP1000, modular construction techniques, or worldwide construction experience.

Westinghouse estimates that the construction duration for the AP1000 will be five years (including the period of fabrication of components off-site prior to on-site construction), and the University of Chicago study indicates that recent nuclear plants in Asia have been constructed in about five years; I have therefore used that period in my analysis. Additionally, the University of Chicago study estimates that the LCOE for a new nuclear plant could be as high as $71 per MWh ($0.071 per kWh); however, those costs assume a seven-year construction period and a capital cost of $1,800 per kW for the type of Framatome reactor under consideration for construction in Finland. Similarly, one of Intervenors' discovery disclosures, *Wind v. Nuclear 2003*, estimates the capital costs of Framatome's European Pressurized Reactor (EPR) to be 1,472 Euros per kW (about $1,900 per kW), assuming a six-year construction period in Europe. However, these capital costs are substantially higher than the estimated capital costs for the AP1000 and the ESBWR and therefore the Framatome plants would not be competitive unless Framatome were able to reduce their costs.

As a point of comparison, Table 1-1 of the University of Chicago study includes estimates provided by other groups. For example, it notes that the Scully Capital Report estimates the LCOE of a new plant similar to the AP1000 to be about $36 to $40 per MWh ($0.036–$0.040 per kWh) (assuming a capital cost of $1,247 per kW) and $44 per MWh ($0.044 per kWh) (assuming a capital cost of $1,455 per kW). The latter cost corresponds to the first new plant, including FOAKE costs spread over the first three new plants. Table 1-1 also notes that a study by Science Applications International Corporation (SAIC) estimates the LCOE for an AP1000 to be between $46 and $51 per MWh ($0.046–$0.051 per kWh) (assuming a capital cost of $1,365 per kW).

The University of Chicago study and Scully Capital report also state that, as more plants of the same design are constructed, the costs of construction will decrease due to a learning curve. Each study estimates a 3 to 5% decrease in costs for construction of each successive plant. As a result, the University of Chicago estimates that a mature AP1000 plant could be constructed in five years with a LCOE of $34 to $35 per MWh ($0.034–$0.035 per kWh) (and possibly as low as $31 per MWh ($0.031 per kWh) assuming a steeper learning curve).

In summary, the estimates of the LCOE for an AP1000 differ significantly depending upon the assumptions used. For the first AP1000 to be constructed, estimates range from about $44 to $54 per MWh ($0.044–$0.054 per kWh) assuming a five-year construction period. For subsequent AP1000s with FOAKE costs previously paid, estimates range from $36 to $47 per MWh ($0.036–$0.047 per kWh). For the N^{th} plant (*i.e.*, a fully mature plant), the costs for the AP1000 range from about $31 to $35 per MWh ($0.031–$0.035 per kWh).

I personally believe that the costs in the Scully Capital Report provide a better estimate of the LCOE of a new AP1000, and that the costs in the University of Chicago study provide a conservative bounding estimate for the AP1000. I base this conclusion upon the following factors:

- The University of Chicago study assumes a capacity factor of 85%. However, U.S. nuclear power plants today typically have capacity factors of about 90%. Accounting for this factor alone would reduce the LCOE by about 5%.
- The University of Chicago study assumes that the entire FOAKE costs will be assessed against the first plant built. However, it is more likely that the costs will be spread over several plants (as assumed in the Scully Capital Report). Additionally, the Department of Energy (DOE) has stated its intent to enter into a cost-sharing agreement with NuStart

Energy Development LLC, to apply for a license for a new plant using the AP1000 or the ESBWR design. Under this cost-sharing agreement, DOE could provide up to 50% of the FOAKE costs for the AP1000 (subject to later recoupment through royalty payments).

- The University of Chicago study assumes that the operations & maintenance (O&M) costs for a new nuclear plant will be $0.021/kWh (excluding fuel costs). This is higher than typical costs in the nuclear industry in the United States.

Therefore, I conclude that it is reasonable to estimate the LCOE for the EGC ESP facility to be within the range provided in the RAI Response (*i.e.*, from $0.031 to $0.046 per kWh for a plant design that has been previously constructed). Additionally, based upon the University of Chicago study and the values in the URD, it would not be unreasonable to postulate an upper bounding LCOE of $0.055 per kWh for a first-of-a-kind plant.

V. ADDITIONAL INFORMATION REGARDING ENERGY ALTERNATIVES

As discussed above, the RAI Response contains an extensive evaluation of wind and solar power alternatives, and combinations thereof. The purpose of this section is to provide additional information to address certain information provided in the Intervenors' exhibits and documents cited in their discovery disclosures with respect to wind, solar, and combinations of alternatives.

A. Wind Generation

1. Wind Energy Potential

[C. Bagnall] Intervenors' exhibits and discovery disclosures indicate that wind power is being used more frequently to generate electricity. Also, as indicated in one of Intervenors' discovery disclosures, *Midwest Power Projects*, Illinois has 3,119 MW of proposed wind power projects. Another discovery disclosure, *Wind Projects Under Development in Illinois*, indicates that there are approximately 13 wind projects under development and $1.5 billion in proposed new investment in wind power in Illinois. I do not dispute these figures. However, it is important to note that all of these proposed projects are in the development stage, undergoing review by state and local environmental agencies and transmission system owners/operators to determine interconnection requirements and costs. Currently, none of these projects is in operation. I have not been able to identify which, if any, of these projects are under construction in Illinois. Based on my experience, few of these projects will actually be brought on line.

Midwest Power Projects also indicates that Illinois has 50 MW of operating wind projects. My research confirms this, as it appears that there is one operating wind farm in Illinois, the 50.4 MW Mendota Hills wind farm in Lee County. I have estimated that this wind farm produces roughly 110,000 MWh per year, which is less than 0.1% (0.0001) of the annual electricity sales in Illinois, based on 2002 retail electricity sales levels for Illinois as reported by the Energy Information Administration.

The potential of a site to generate wind power is typically determined based upon its wind power class. Wind resource maps identify areas by the following wind power classes, which range from Class 1 (the lowest) to Class 7 (the highest), at a height of 50 meters with the following average wind speeds:

- Class 1 (< 12.5 mph)
- Class 2 (12.5–14.3 mph)
- Class 3 (14.3–15.7 mph)
- Class 3+ (15.5–15.7 mph)
- Class 4 (15.7–16.8 mph)
- Class 5 (16.8–17.9 mph)
- Class 6 (17.9–19.7 mph)
- Class 7 (> 19.7 mph)

An area's viability for commercial generation of electricity from wind power is dependent upon the wind power class of the site. In general, areas rated as Class 4 and above are considered to be potentially commercially viable sites for wind power facilities. Some Class 3+ areas may also be suitable for wind power facilities.

According to the DOE's wind resource maps for Illinois, provided on page 20 of the RAI Response, there are no areas in Illinois that are rated as Class 5 or above. However, as discussed in detail on pages 5 and 20 of the RAI Response, there are some areas in Illinois that are rated as Class 4 and 3+ which might be viable for commercial generation of electricity from wind power.

In general, wind energy capacity factors for Class 4 areas range from 17–29%. Under the most optimistic projections, Class 4 capacity factors may increase to about 35% by 2020 due to expected improvements in wind turbine technology. These low capacity factors, by themselves, demonstrate that wind power is unable to generate baseload power; that is a facility is able to continuously produce power except for refueling, planned, and forced outages.

As indicated on page 5 of the RAI Response, the total amount of Class 4 and Class 3+ land in Illinois is about 1,800 km^2 and the total wind potential from all of these sites combined is about 9,000 MWe of installed capacity. If it is conservatively assumed that Class 3+ wind areas have the same capacity factor as Class 4, and all of the wind resources in Illinois' Class 3+ and Class 4 sites were developed, based upon a 17% capacity factor, the resulting wind facilities would have an average annual output of 1,530 MWe. Assuming a maximum 29% capacity factor, the resulting wind facilities would have an average annual output of 2,610 MWe. However, it is unrealistic to assume that all of Illinois' Class 3+ and Class 4 wind sites (*i.e.*, 1,800 km^2 or approximately 444,790 acres) will be fully developed with wind projects. In comparison, based upon a capacity factor of 90%, the EGC ESP facility would have an average annual output of 1962 MWe.

In summary, wind energy alone is not a viable alternative to the proposed EGC ESP facility because it cannot generate baseload power and cannot realistically produce a total amount of energy in Illinois equivalent to that generated by the EGC ESP facility.

2. **Wind Energy Costs**

[C. Bagnall] I agree with the Intervenors that improvements have been made in wind power technology. These improvements have, in part, been characterized by increases in the size of wind turbines. In recent years, the largest commercially available wind turbines were between 1 MW and 1.6 MW. Most wind turbines currently being installed in the United States have a peak capacity of approximately 1.5 MW or 1.6 MW. However, General Electric Wind Energy is currently producing 2.3, 2.5, and 2.7 MW land-based turbines and 3.6 MW turbines for offshore use. A prototype of the 2.5 MW unit and about 8 of the 3.6 MW units have been installed, but these large turbines are still not readily available for large-scale commercial use. Clipper Wind Power also recently announced the groundbreaking for installation of a commercial prototype of its 2.5 MW wind turbine; again it is not yet commercially available in large numbers.

A recognized benefit of wind power generation is that it has zero fuel costs. Moreover, improvements in technology have resulted in lowering the cost of wind power. As indicated in one of Intervenors' discovery disclosures, *The Most Frequently Asked Questions about Wind Power*, the cost of electricity from utility-scale wind power projects was approximately $0.30/kWh in the 1980's. The cost has since dropped. As stated on page 6 of the RAI Response, the current total cost of generating electricity from wind power ranges from $0.03–$0.06/kWh. The cost of electricity from large wind turbines (> 2 MW) is estimated to be similar to the costs from 1.6 MW units, or about $0.03/kWh to $0.06/kWh. This wide range of cost reflects the different capacity factors for different class sites, the size of the facility, the availability of tax credits, and other factors. For example, the total cost of generating electricity in Class 5 sites and above is approximately $0.047/kWh. In contrast, wind power produced in Class 4 sites costs about $0.054/kWh and $0.064/kWh in Class 3+ sites, which exceed the costs of electricity from a nuclear plant. One of Intervenors' exhibits, *Repowering the Midwest*, optimistically estimates that wind generating costs will drop to about $0.03–$0.04/kWh by 2020.

The RAI Response and the Intervenors' disclosures note that several sites in the upper Midwest have greater wind potential than Illinois. As indicated by *Midwest Wind Power Projects*, there are 1,389 MW of operating and 8,640 MW of proposed wind power projects in Indiana, Michigan, Wisconsin, Missouri, Iowa, Minnesota, Kansas, Nebraska, and North and South Dakota. However, any development of wind resources outside Illinois at the scale of the proposed EGC ESP facility would need to address the availability of long-distance transmission lines. Current economics favor remote locations for large-scale wind and solar generation, but the transmission system infrastructure to support transmission of large bulk power from these areas is currently not available and investment in new long-distance transmission infrastructure is not forthcoming. Any new long-distance transmission development could take at least ten years from proposal through permitting and construction.

The ability to transmit power on existing lines from a remote site in the upper Midwest is also limited. A 2004 DOE study, *Analysis of Wind Resource Locations and Transmission Requirements in the Upper Midwest*, highlights this concern. This study characterizes East-West transmission through the Midwest—running through parts of Illinois, Iowa, Minnesota, and Wisconsin—as a "no-man's land." In other words, there are very few existing East-West transmission lines in the Midwest. As a result, the Midwest is considered "constrained" in terms of transmission. According to the North American Electric Reliability Council, more than two-thirds of any given transmission line in the Midwest is fully utilized, especially during peak periods. Utilization of more than two-thirds of any given transmission line is considered high under standard usage rates. Therefore, existing long-distance transmission lines cannot accommodate the additional load that would be imposed by new large wind power projects sited in remote locations in the upper Midwest. The DOE notes that new transmission development projects are focusing on *maintaining* reliability for existing sources, rather than expanding capacity of the grid. The significant additional costs required to expand the transmission system to accommodate large-scale, remotely-located wind farms are not reflected in the above-cited costs of wind power energy.

Furthermore, as indicated in the 2004 DOE study, there are existing voltage and stability issues associated with transmission of power in the upper Midwest states. Development of large wind farms in the Upper Midwest would aggravate these voltage and stability problems. Therefore, with respect to grid stability, locating new generating facilities in southern Illinois is preferable to locating new facilities in the Upper Midwest.

The cost of new transmission is high. For example, recent studies have assessed the cost of transmission lines from North Dakota to the Chicago metropolitan area. One such study, *North Dakota to Zion High Voltage Direct Current (HVdc) Transmission Feasibility Study*, noted costs of new transmission that ranged from $746.6 million to $946.5 million, depending on the configuration and size of generation and transmission. The significant additional costs required to expand the transmission system to accommodate large-scale, remotely-located wind farms are not reflected in the costs of wind power energy discussed above, or in the RAI Response.

I understand that in the future, there may be methods for reducing the costs of transmission of energy generated by wind power. For example, on page 30 of *Repowering the Midwest*, it is postulated that wind-generated electricity in areas far removed from loads could be converted to hydrogen by electrolysis, and transmitted by pipeline to population centers such as Chicago, Illinois, where it could be used to produce electricity in fuel cells. However, *Repowering the Midwest* does not evaluate the environmental impacts associated with such transmission. Further, long-distance pipeline transmission of hydrogen is not close to being commercially available, and there are no large-scale electrolysis plants available. Therefore, transmission of wind energy by means of hydrogen pipeline is not a reasonable alternative and is not analyzed here.

Direct public sector support programs help to reduce capital and operating costs for wind power. A five-year depreciation schedule is available for renewable energy systems under the Economic Recovery Tax Act of 1981. The Federal Production Tax Credit (PTC) has been renewed through the year 2005, which provides a tax credit of $0.018 per kWh for wind facilities placed in service after December 31, 1993 and before January 1, 2006. The availability of the PTC has proven to be a key factor in the development of wind projects. Although a two-year extension of the PTC has been proposed, it is still uncertain whether the PTC will be renewed for projects coming online after 2005.

At the state level, 17 states have implemented renewable portfolio standards requiring retail electricity sellers to provide a minimum percentage of their electricity from renewable resources by a certain date. In August 2004, Illinois enacted legislation creating the Illinois Resource Development and Security Act. This legislation adopted a statewide renewable energy goal of at least 5% of total energy by 2010, and at least 15% by 2020. Also, Illinois has established Public Benefits Funds (PBFs) to fund renewable energy. Typically, a small per-kWh charge is added to residents' electricity bills to raise the needed funds. Many PBFs make funds available to promote wind development. In Illinois, wind projects greater than 10 MW in size are eligible to have up to 10% of project costs paid for out of the PBF.

3. Wind Energy Environmental Impacts

[W. Maher] Wind generation produces no air pollution, greenhouse gases, or solid or liquid waste. Wind power also does not use coolant water or have thermal discharges.

Wind turbines can, however, cause deaths to birds due to collisions. As discussed by Intervenors' Exhibit 14, *Wind Energy for Electric Power*, studies performed at sites around the U.S. measure one or two bird deaths per turbine per year. However, bird deaths due to wind generation are a small fraction of those caused by other human activities.

Wind turbines can also generate a relatively large amount of noise. Technological advancements, however, continue to lessen noise problems associated with wind turbines. As a result, modern wind turbines are less noisy than their predecessors. Further, the level of noise drops with increased distances. For example, *Wind Energy for Electric Power* indicates that the noise level generated from a typical wind farm at 350 meters distance varies between 35 and 45 dB(A). If the wind facilities were located in order to mitigate the noise impacts, the impacts would be small.

Additionally, wind facilities may have aesthetic impacts. Nationwide, many communities have opposed the placement of nearby wind projects. However, if the wind facilities were located in order to mitigate the aesthetic impacts (*e.g.*, in remote areas), the impacts would be small.

Lastly, wind power requires a relatively large amount of land, even though some of the land between wind turbines may be available for other uses. As indicated by the RAI Response, a 2 MW turbine requires approximately a quarter of an acre of dedicated land for the actual placement of the wind turbine, which is consistent with the information contained in Intervenors' Exhibits 12, 14, and 15. If all of Illinois' 1,800 km^2 of Class 4 and Class 3+ sites were developed using 2 MW turbines, 9,000 MW of installed capacity would utilize 1,125 acres for the placement of wind turbines. Based upon a capacity factor of 17%, this project would have an average annual output of 1,530 MWe, which corresponds to 0.73 acres/MWe. Even if an optimistic capacity factor of 29% is used, this project would occupy 0.43 acres/MWe. In contrast, based upon a capacity factor of 90%, the EGC ESP facility would have an average annual output of 1,962 MWe and would only occupy approximately 461 acres (approximately 0.23 acres/MWe).

B. **Solar Generation**

[C. Bagnall] Solar power is intermittent as it is dependent on the availability and the strength of sunlight. Solar generation is not available to produce power at night or on overcast days. In Illinois, a solar energy facility is estimated to have about an 18.5% capacity factor. Therefore, solar power, by itself, cannot be used to generate baseload power, which assumes that a facility is able to continuously produce power, except during refueling, planned, and forced outages.

A June 2004 report by the Special Task Force on the Condition and Future of the Illinois Energy Infrastructure for Illinois (www.blackoutsolutions.org) indicates that there are about 100 distributed solar electric installations in Illinois producing 2,000 MWh per year or about 228 average kW statewide. Most of these are located on buildings as distributed generation. This is insignificant compared to the total electricity generated in Illinois. Currently, photovoltaics (PV) is the only solar technology being used in Illinois.

The RAI Response discusses a number of solar generation technologies, and an extensive review of environmental impacts and economic costs of solar technologies. These are noted below, with some discussion and clarification.

1. Concentrating Solar Power Systems

As discussed on pages 9–11 of the RAI Response, there are three kinds of concentrating solar power systems. These systems are:

- Trough Systems—The sun's energy is concentrated by trough-shaped reflectors onto a receiver pipe running along the inside of the curved surface. This energy heats oil flowing through the pipe and the heat energy is then used to generate electricity in a conventional steam turbine generator. A collector field comprises many troughs in parallel rows aligned on a north-south axis. Currently, all trough plants are "hybrids"—trough systems must use fossil-fueled generation to supplement solar output during periods of low solar radiation. This technology is still in the development stage and is not commercially available.
- Dish Engine Systems—A dish/engine system is a stand-alone unit composed of a collector, a receiver, and an engine. This dish-shaped surface collects and concentrates the sun's energy onto a receiver that absorbs the energy and transfers it to the engine's working fluid. The engine converts the heat by compressing the working fluid when it is cold, heating the compressed working fluid, and then expanding it through a turbine to produce work. The mechanical power is converted to electrical power by an electrical generator or alternator. These

systems can be combined with natural gas generation to provide continuous power generation. While ongoing demonstration projects indicate the potential for commercial viability, the dish engine systems are currently not commercially available.

- Power Tower Systems—The sun's energy is concentrated by a field of hundreds or thousands of mirrors onto a receiver located on top of a tower. The concentrated solar energy then heats molten salt flowing through the receiver, and the salt's heat energy is used to generate electricity in a conventional steam turbine generator. Similar to the trough and dish engine systems, the power tower system is currently not commercially available.

The current costs of concentrating solar power systems range from $0.09–$0.12/kWh for southwestern United States. Future advances in technology are expected to decrease the cost of concentrating solar power systems in the next few decades to $0.04–$0.05/kWh for the southwestern United States. Because Illinois receives about one-half the amount of solar radiation compared to southwestern United States, the current costs of electricity from such facilities in Illinois are estimated to be about twice as high or approximately $0.18–$0.24 based on commercially available technology. As a result, Illinois has no economically viable areas for developing concentrating power systems.

2. **Solar Photovoltaics**

[C. Bagnall] Solar PV directly convert solar energy into electricity. As discussed in more detail on page 12 of the RAI Response, PV capital costs are $5–$20 per watt. This wide range in cost is due to site specific factors (such as variations in the cost of land, site considerations, orientation, structures, *etc.*). The twenty-year life-cycle cost ranges from $0.20–

$0.50/kWh in southwestern United States. The cost of generating electricity from PV in Illinois would be approximately twice as high because it receives about 50% less solar radiation.

PV cell conversion efficiencies for single or multicrystalline silicon ranges from about 11–15%. PV cell conversion efficiencies of 25% are the maximum recorded laboratory efficiency for single crystalline silicon. Improvements in production and technology could decrease the cost of grid-connected PV systems to $0.15–$0.20/kWh by the year 2020 in southwestern United States. Again, the costs in Illinois are estimated to be twice as high.

3. Environmental Impacts of Solar Power

[W. Maher] As discussed on page 13 of the RAI Response, the land required for solar generating technologies is about 2.5 acres/MW for California's Mojave Desert and 12 acres/MW for Illinois. Page 13 of the RAI Response also indicates that this land use is preemptive; land used for solar facilities would not be available for other uses such as agriculture. Assuming PV cell conversion efficiency could be improved to 25%, PV cells would require about 7.5 acres/MW. At this conversion efficiency, and based upon the amount of available solar radiation in Illinois, PV would require approximately 38 km^2 (9,390 acres) to generate the electricity equivalent to the EGC ESP facility.

The Intervenors have argued that the land impacts could be reduced if solar panels were distributed on the tops of roofs of buildings. However, independent power producers, such as EGC, do not typically utilize such distributed means for generating electricity. In particular, independent power producers, including EGC, do not have rights to install solar panels on buildings that they do not own. Therefore, distributed solar panels are not a reasonable means for EGC to generate electricity for sale on the wholesale market.

During operation, PV and solar thermal generation produce no air pollution, greenhouse gases, solid waste, or noise, and require no transportable fuels. Depending on the solar technology, there may be thermal discharge impacts from concentrating solar power systems, which operate steam turbines and use water to condense the steam. The water then discharges its heat, either directly to water bodies or to cooling towers.

C. Combinations of Alternatives that Could Generate Baseload Power in an Amount Equivalent to the Proposed EGC ESP Facility

1. Combinations of Wind and Solar Power

[C. Bagnall] It might be postulated that combinations of wind power and solar power alone could produce baseload power (*i.e.*, the solar power facilities operate in the day, the wind power facilities operate at night, and the wind and solar facilities are spread throughout the state making it more likely that the wind is blowing and/or the sun is shining somewhere in the state). However, this is unrealistic and could not be relied upon as a dependable source of baseload power. Experience shows that there are times when the wind statewide is insufficient to generate any electricity for extended periods of time. Also, there will be many occasions when the sun is not shining and there is insufficient wind to generate power. During such periods, the wind and solar power facilities would need to be supplemented or replaced by significant energy storage systems or fossil-fueled facilities to produce dependable baseload power.

Accordingly, the combination of wind and solar facilities, without either significant energy storage or other dispatchable generation backup, cannot be relied upon to produce baseload power over the long term and certainly not baseload power equivalent to that produced by the EGC ESP facility. Therefore, the amount of power produced by a combination of wind and solar power facilities alone cannot meet the fundamental purpose of this project. Thus, in order to produce baseload power equivalent to the EGC ESP facility, wind and solar facilities would need to be supplemented by substantial amounts of energy storage systems or other generating facilities.

2. Combinations of Wind and Solar Power with Energy Storage Systems

[C. Bagnall] As noted above, wind and solar power are, by their nature, intermittent resources and therefore do not produce baseload power. The use of energy storage systems in combination with wind and/or solar facilities would be able to levelize the wind and solar electricity generation into a more constant output (*i.e.*, baseload power).

Conceptually, baseload electricity generation could result from storing the power produced from wind and/or solar facilities and releasing it when the wind and solar facilities are not generating power. However, at the scale of the EGC ESP facility, energy storage of wind and/or solar power in Illinois is either not available or would not be economically viable. For example, the storage of even one day's output at 2,180 MW is well beyond any demonstration projects using batteries, compressed air, hydrogen, or other storage mechanism. Furthermore, the cost of such systems, even if available, would be prohibitive. Adding the significant cost of storage systems to the cost of wind or solar facilities would render the total cost non-competitive. I am also not aware of any recent large-scale wind farms that utilize storage systems, and solar storage systems are not available on this scale or are still in the demonstration stage. In the northwestern United States, existing hydropower reservoirs are used to levelize wind generation, but this approach is not available at this scale in Illinois. The only alternative in Illinois might be pumped storage; however, pumped storage is not available in Illinois to generate such large amounts of power, and the costs to develop such storage would be prohibitive. Furthermore, pumped storage is generally used to generate power during peak loads rather than as a means of producing baseload power in combination with other facilities.

Therefore, while combinations of wind and/or solar facilities with energy storage systems could generate baseload power, the costs of electricity from such combinations in Illinois would be greater than the costs from a nuclear facility, and there is currently not any commercially viable method for storing such large amounts of energy in Illinois.

3. Combinations of Wind and Solar Power with Coal and/or Natural Gas-Fired Facilities

a. Potential for Generating Baseload Power

[C. Bagnall] As discussed above, because of their intermittent nature, wind and solar power, by themselves, cannot be used to generate baseload power. Wind and solar generation in combination with coal and/or natural gas-fired facilities, however, could be used to generate baseload power. The coal and/or natural gas-fired generation would be displaced when the wind and/or solar resource is producing power.

Because wind and solar power alone cannot reliably produce baseload power over the long term, it would be necessary to construct a coal and/or natural gas-fired facility that has a peak capacity of 2,180 MW in combination with wind and/or solar facilities to produce baseload power equivalent to the EGC ESP facility. For example, a combination could involve coal and/or natural gas-fired generation of 2,180 MW and wind and solar power capacity of any amount that one may care to postulate. Whenever the wind/solar generation is less than 2,180 MW (either because the wind is not blowing, the sun is not shining, or the installed capacity is less than 2,180 MW), the coal and/or natural gas-fired generation would need to run to bring the total generation output to 2,180 MW.

This approach, however, presents some concerns. For example, for coal-fired generation, rapid changes in operating levels (*i.e.*, based on actual wind conditions) is not realistic unless the coal-fired technology utilizes combustion turbines rather than steam boilers and steam turbines.

Steam boilers are not well adapted to rapid changes in operating levels over the long term; operating them in this fashion creates maintenance concerns for the equipment. One potential solution to this issue is to install only that solar and wind power capacity that allows the coal-fired generation to operate at some minimum level. This has the net effect of reducing the amount of wind or solar installed in the combination facility. Natural gas-fired generation, because of its greater operational flexibility, is better suited to operating in combination with wind and solar.

b. **Costs of Combinations**

The cost of electricity production (on a per kWh basis) from a coal or natural gas-fired facility in combination with wind and/or solar facilities would increase relative to the cost of baseload coal or natural gas-fired facilities because the capital costs and fixed operating costs of the coal/natural gas facilities would be spread across fewer kWh because their generation would be displaced by wind and solar power generation. For example, assuming a coal or natural gas-fired facility operating at a 90% capacity factor has a fuel cost $.02/kWh (which is low at current prices) and $.027/kWh for capital and fixed operating costs, operating this same facility at 60% capacity (due to the availability of solar and wind power) will result in capital and fixed operating costs of $.041/kWh ($0.027 * 90%/60% = $.041) plus the $.02/kWh for fuel, for a total unit cost of $.061/kWh. Thus, use of coal/natural-gas facilities in combination with wind/solar facilities would render the coal/natural-gas facilities uncompetitive relative to a nuclear facility. As mentioned previously, the cost of electricity from wind/solar facilities is higher than the cost of electricity from a nuclear facility. Thus, the cost of the combination would be greater than the cost from a nuclear facility.

c. Environmental Impacts of Combinations

[W. Maher] The environmental impacts of wind and solar facilities are discussed above and in the RAI Response at pages 8, 13, and 26–33. The environmental impacts of coal or natural gas-fired generation are also discussed in the RAI Response and in the ER. Additionally, the operation of coal or natural gas-fired generation will result in heat dissipation to the atmosphere. The heat discharge could be manifested in the form of vapor plumes and have visual, aesthetic and ecological impacts.

If the wind/solar facilities have a peak capacity less than the capacity of the EGC ESP facility, the construction and operational environmental impacts of the wind/solar facilities would be reduced relative to such facilities that have a capacity equivalent to the EGC ESP facility. For example, if the wind/solar facilities have a peak capacity of 1,500 MWe (or about 75% of the capacity of the ESP EGC facility), the amount of land needed for those facilities would be approximately 75% of that needed for wind/solar facilities that had a peak capacity equivalent to that of the EGC ESP facility. The aesthetic and noise impacts of the wind facilities would also be reduced, especially if fewer facilities were needed.

The greater use of wind/solar facilities would not reduce the construction impacts but would reduce the fuel and fuel-burning operational impacts (*e.g.*, gaseous emissions) from a coal or natural gas-fired facility, since the wind/solar facilities would supplant the coal or natural gas-fired facility when the wind/solar facilities operate. For example, as shown on page 27 of the RAI Response, air quality impacts of the natural gas/coal facilities (Sulfur Oxide, Nitrous Oxide, Carbon Monoxide, and Particulate Matter discharges) would be reduced based on the level of generation by the wind/solar facilities. Nevertheless, even if the combination of wind/solar facilities with natural gas/coal facilities were selected so as to minimize environmental impacts, the combination would not be environmentally preferable to a nuclear facility. Any such combination would still need relatively large amounts of energy to be generated by the natural gas/coal facilities in order to be able to produce baseload power equivalent to the EGC ESP facility. Therefore, the air quality impacts from the natural gas/coal facilities would likely be MODERATE. Even if such impacts could be reduced to SMALL, the cumulative impacts from this combination of facilities would still not be preferable to the impacts from a nuclear facility. Similarly, if the wind/solar facilities were to generate any appreciable amount of energy, their land impacts would at least be MODERATE. Furthermore, even if the land impacts could be reduced to SMALL, the cumulative impacts still would not be preferable to the impacts from a nuclear facility. Therefore, even under optimal conditions, the combination of wind/solar facilities and natural gas/coal facilities would not be preferable to a nuclear facility.

VI. COMPARISON OF THE DEIS AND THE RAI RESPONSE

[W. Maher] I have reviewed the NRC Staff's analysis of alternatives to the proposed EGC ESP facility in Chapter 8 of the DEIS. Below, I have summarized those sections of the DEIS that address wind and solar power and combinations of alternatives that, together, could generate baseload power in an amount equivalent to the EGC ESP facility. Based upon my review, I have concluded that the DEIS's analysis of wind and solar power and combinations involving wind and solar is consistent with the information provided by EGC in the RAI Response and this affidavit.

- **Generally**—As indicated in Section 8.2.3 of the DEIS, the proposed EGC ESP facility would operate as a baseload generator and merchant plant. Therefore, the DEIS correctly notes that any feasible alternative to the EGC ESP facility would need to generate baseload power. According to the DEIS, the NRC Staff reviewed the RAI Response's analysis of wind and solar power and agrees with EGC's conclusion that these generation options are not reasonable alternatives to the EGC ESP facility.

- **Wind Power Generation Potential in Illinois**—Section 8.2.3.1 of the DEIS evaluates Illinois' potential for wind power generation. For example, the DEIS acknowledges that approximately 8% of Illinois' land has a wind-power classification sufficient to support wind generation. Further, the DEIS accounts for Illinois' potential peak capacity of 9,000 MWe from its 1,800 km^2 of Class 4 and class 3+ wind sites. Page 5 of the RAI Response also relies upon these same figures in its wind power analysis and therefore is consistent with the DEIS with respect to wind generation potential.
- **Environmental Impacts Associated with Wind Power Generation**—Section 8.2.3.1 of the DEIS also recognizes there are environmental concerns related to wind generation. For example, the DEIS notes that wind power uses a relatively large amount of land (50 acres per MW), even though some of the land between wind turbines may be available for other uses. Additionally, the DEIS notes that wind turbines can cause deaths to birds due to collisions, although this has been a serious concern at only one location, Altamont Pass in California. Both the RAI Response (on page 8) and this affidavit (in section V.A.3) reach similar conclusions with respect to environmental impacts associated with wind power generation. Accordingly, the RAI Response and DEIS are consistent relative to wind power's environmental impacts.
- **Wind Power's Inability to Generate Baseload Power**—As indicated in section 8.2.3.1 of the DEIS, wind power is intermittent. The DEIS estimates that annual capacity factors for wind plants are less than 30 percent. Consequently, wind power, by itself, cannot generate baseload power. The RAI Response, on pages 5 and 8, provide similar data with respect to wind power's relatively low capacity factor and inability to generate baseload power and is therefore consistent with the DEIS.

- **Combination of Wind Power and Energy Storage**—Section 8.2.3.1 of the DEIS notes that wind power, in conjunction with energy storage systems, could produce baseload power. However, the DEIS also states current energy storage costs are too expensive for wind power to serve as a large baseload generator. Likewise, as discussed above in section V.C.2, this affidavit similarly concludes that wind power in combination with energy storage could produce baseload power, but the costs of electricity from such combinations would be greater than the costs from a nuclear facility, and there is currently not any commercially viable method for storing such large amounts of energy in Illinois.
- **DEIS Conclusions with Respect to Wind Power Generation**—Based on the intermittent nature of the wind resource, Section 8.2.3.1 of the DEIS concludes that wind power generation is not a viable alternative to the EGC ESP facility. This conclusion is consistent with the conclusions in this affidavit and the RAI Response.
- **Solar Power Generation Potential**—Section 8.2.3.4 of the DEIS estimates that the solar resource for the EGC ESP facility site is an annual average of 4.0 to 4.5 $kWh/m^2/day$ for flat-plate solar systems and 3.5 to 4.0 $kWh/m^2/day$ for solar concentrating systems. Areas in the southwest United States are estimated to receive up to 7.5 $kWh/m^2/per$ day. The DEIS approximates that the average capacity factor of PV cells is about 25%, and the capacity factor for solar thermal systems is about 25–40%. The RAI Response provides similar figures with respect to the amount of solar radiation received by Illinois. Page 9 of the RAI Response indicates that Illinois' solar energy varies from 4–5 $kWh/m^2/day$ in the summer to 2–3 $kWh/m^2/day$ in the winter. Further, the RAI Response estimates that the areas with the highest amount of solar radiation are in the southwestern part of Illinois with rates up to 6–7 $kWh/m^2/day$ at the brightest time of a summer day and that most of Illinois falls in the range

of 5.5–6 kWh/m^2/day at the brightest time of a summer day. The RAI Response approximates that the southwestern United States can generate up to 10–12 kWh/m^2/day of solar radiation during the brightest part of summer days. Further, the RAI Response and this affidavit, at sections V.B and V.B.2, estimate slightly lower capacity factors for solar technologies. However, even if the DEIS's higher capacity factors are assumed, solar power nevertheless cannot produce baseload power and therefore is not a reasonable alternative to the proposed EGC ESP facility. Furthermore, even at the higher capacity factors cited in the DEIS, solar power systems would not be economically competitive with nuclear power. Accordingly, the RAI Response and this affidavit are consistent with the DEIS with respect to solar power's generation potential.

- **Combination of Solar Power and Energy Storage**—Section 8.2.3.4 of the DEIS states that energy storage requirements limit the use of solar energy systems as baseload electricity supply. As discussed above in Section V.C.2, this affidavit similarly concludes that solar power in combination with energy storage could produce baseload power, but the costs of electricity from such combinations would be greater than the costs from a nuclear facility. Consequently, the DEIS is consistent with the information provided in this affidavit relating to the combination of solar power and energy storage.
- **Environmental Impacts Associated with Solar Power Generation**—Section 8.2.3.4 of the DEIS states that there are environmental impacts relative to solar power, including wildlife habitat and aesthetics. Further, construction of solar generating facilities has substantial impacts on land use. For example, the DEIS estimates that PV requires 142 km^2 per 1,000 MWe and approximately 57 km^2 per 1,000 MWe for solar thermal systems. Both the RAI Response (on pages 13 and 22) and this affidavit (Section V.B.3) provide comparable

numbers for land usage and reach similar conclusions regarding land impacts and therefore are consistent with the DEIS with respect to environmental impacts associated with solar power generation.

- **Costs Associated with Solar Power Generation**—Section 8.2.3.4 of the DEIS states that solar power technologies (both PV and thermal) cannot currently compete with conventional nuclear and coal and natural-gas-fired technologies because of their higher costs. For example, the DEIS states that the cost of producing electricity from concentrating solar technologies is estimated to be $0.09–$0.12/kWh. Pages 11 and 12 of the RAI Response discuss in detail the costs associated with generating electricity from solar power. This discussion in the DEIS includes the same cost figure as cited in the RAI Response.
- **DEIS Conclusions with Respect to Solar Power Generation**—For the reasons discussed above, Section 8.2.3.4 of the DEIS concludes that a solar energy facility at or in the vicinity of the EGC ESP facility would not be an economical alternative to the construction of a nuclear power generation plant that would be operated as a baseload plant. This conclusion is consistent with the conclusion in the RAI Response and this affidavit.
- **Combinations of Alternatives**—Section 8.2.3.10 of the DEIS states that individual alternatives to the EGC ESP facility might not be sufficient on their own to generate EGC's target capacity. However, it notes that a combination of alternatives could be used to generate baseload power and be cost-effective. The DEIS assumed a combination of three 550 MWe natural gas combined-cycle generating units at the site; 60 MWe of wind energy, hydropower, or pumped storage; 90 MWe from biomass sources, including municipal solid waste; and 400 MWe from purchased power, conservation, and demand-side management. The DEIS concludes that the EGC ESP facility is either environmentally preferable or

equivalent to this combination of alternative power generation alternatives. As indicated in Table 8-4 of the DEIS, the EGC ESP facility is preferable to this combination in the areas of air resources, ecological resources, water resources, and aesthetics. Section V.C.3 of this affidavit and Tables 9.2-6 and 9.2-7 of the RAI Response also evaluate a combination of alternatives involving wind and/or solar generation with coal or natural gas-fired generation. Similar to the DEIS, the RAI Response and this affidavit conclude that nuclear power is environmentally preferable to combinations in the areas of land usage, air quality, and aesthetics. Additionally, this affidavit notes that even if the environmental impacts of the combinations were minimized, the combination of wind/solar facilities and natural gas/coal facilities would not be environmentally preferable to a nuclear facility.

Accordingly, based on my review, the DEIS is consistent with the RAI Response with respect to matters such as potential for generating baseload power, availability, costs, and environmental impacts of wind and solar power, and combinations of these alternatives with technologies that, together, could generate baseload power in an amount equivalent to the proposed EGC ESP facility.

VII. EVALUATION OF INTERVENORS' EXHIBITS IN SUPPORT OF CONTENTION 3.1 AND DOCUMENTS IDENTIFIED BY INTERVENORS IN THEIR DISCOVERY DISCLOSURES PURSUANT TO 10 CFR § 2.336.

[W. Maher] I have reviewed each of Intervenors' Exhibits in support of Contention 3.1 and the documents identified by Intervenors in their discovery disclosures. The attached tables provide a summary of the relevant information in the documents identified by the Intervenors. I have compared the RAI Response with the information cited by Intervenors relative to wind and solar power, including combinations of these alternatives with coal or natural gas-fired generation. I have determined that the information cited by Intervenors in their Exhibits and disclosures is consistent with the information in the RAI Response. These tables are attached to this affidavit as Enclosures 4, 5, and 6.

Further, none of Intervenors' exhibits addresses the environmental impacts of electricity associated with the operation of a new nuclear facility. One of the documents disclosed by the Intervenors, which evaluates the economic factors affecting the future of nuclear power in the United States, is discussed in section IV of this affidavit. Therefore, the costs provided in the document disclosed by the Intervenors are consistent with the cost estimates provided in the RAI Response.

VIII. CONCLUSIONS

[Maher and Bagnall] Based upon the information provided in the RAI Response and our affidavit, we conclude that neither wind power nor solar power alone can generate baseload power. Additionally, we conclude that wind power and solar power are neither economically nor environmentally preferable to the EGC ESP facility. Finally, while combinations of wind and solar power with energy storage systems or coal and/or natural gas-fired facilities could be used to generate baseload power (and to reduce the environmental impacts of generation of baseload power from coal or natural gas-fired facilities alone), the levelized cost of electricity from the coal or natural gas-fired facilities would increase, and the combination would not be economically or environmentally preferable to the EGC ESP facility.

State of Pennsylvania)

County of Chester)

I declare under penalty of perjury that the foregoing affidavit and the matters stated therein are true and correct to the best of my knowledge, information and belief.

William D. Maher

Subscribed and sworn before me this 16th day of March, 2005.

Notary Public

COMMONWEALTH OF PENNSYLVANIA
Notarial Seal
Vivia V. Gallimore, Notary Public
Kennett Square Boro, Chester County
My Commission Expires Oct. 6, 2007
Member, Pennsylvania Association Of Notaries

My Commission Expires: 10-6-07

State of Oregon)

County of Multnomah)

I declare under penalty of perjury that the foregoing affidavit and the matters stated therein are true and correct to the best of my knowledge, information and belief.

Curtis L. Bagnall

Curtis L. Bagnall

Subscribed and sworn before me this 16 th day of March, 2005.

Jo Ann McConnell

Notary Public

My Commission Expires:
1-29-2007

OFFICIAL SEAL
JO ANN McCONNELL
NOTARY PUBLIC-OREGON
COMMISSION NO. 365142
MY COMMISSION EXPIRES JANUARY 29, 2007

ENCLOSURE 1

RESUME OF WILLIAM MAHER

AEROTEK ENGINEERING, WORKING AS SECONDED EMPLOYEE FOR EXELON, Kennett Square, PA **1999-Present**

Environmental Lead 1999 – Present

Environmental Lead for Early Site Permitting with full scope responsibility for coordinating site activities, developing environmental tactics, developing industry positions with Nuclear Energy Institute (NEI) Task Force for first-of-a-kind licensing actions, and interfacing with various Federal, State, and local agencies.

- Developed methodology for presentation and impact analysis for Exelon Early Site Permit application.
- Industry Task Force representative for developing responses to NRC issues in the development of the environmental report for Early Site Permit applications.
- Provided direct interface with State regulatory agencies for explanations of purpose and scope of the Early Site Permit
- Acted as single point contact for NRC in responding to environmental questions concerning Early Site Permit application.

Environmental Lead for License Renewal with full scope responsibility in technical and environmental methodology development.

- Developed methodology and procedural requirements to be used by License Renewal Group incorporating requirements of 10 CFR 51/54 and NEI 95-10.
- Originated database and initiated informational relationships for renewal application.
- Developed, reviewed, and provided recommendations on results of age-related degradation studies and providing credit for existing plant programs for Peach Bottom, Quad Cities, Dresden, and Hatch.
- Set-up renewal application format and profile to enable ease of review by regulatory agencies.
- Interfaced with State and Federal regulatory agencies to ensure timely review and approval of application and determination of environmental impacts.
- Member of International Speaking Group for License Renewal environmental impacts for utilities in Japan, positioning Japan with United States in activities performed.

SEQUOIA CONSULTING GROUP, Plainville, MA **1997 - 1999**

Engineering Consultant 1997 – 1999

Consulting services and licensing support for current issues facing individual utilities.

- Specified sizing criteria for replacement Emergency Core Cooling System strainers for Cooper, Vermont Yankee, and FitzPatrick.
- Containment Issues Task Force member for Vermont Yankee updating discrepancies found in the Vermont Yankee design basis. Instituted revision to design and licensing basis for new containment analysis including receiving regulatory approval for processes and methods.
- Helped develop test plan for industry group investigating safety related coatings. Wrote position for industry groups in response to Generic Letter 98-04.

PUBLIC SERVICE ELECTRIC AND GAS, Newark, NJ **1985 - 1997**

Supervisor - Engineering Assurance 1996 – 1997

Supervisor in charge of teams of engineers conducting design/licensing basis validations and verifications of the Salem and Hope Creek facilities.

- Instituted method for dealing with and responding to reported criteria to NRC when review teams had a discrepancy with design/licensing basis.
- Developed design review schedule and method based on the significance of the system being reviewed.
- Developed conversion methods and criteria for design basis documents into plant configuration control system.

Senior Project Engineer 1991 – 1995

Senior Engineer with direct project management responsibility for multi-disciplined teams. Teams included design, construction, testing, and financial controls.

- Manage divisional operations, information, planning, marketing, regulatory compliance, contract negotiation, safety, and union relations.
- Hope Creek Response Team Member for engineering inspection of Residual Heat Removal, Core Spray, Service Water, and Safety Auxiliary Cooling systems, as well as Emergency Diesel System Functional Inspection.
- Served as member of international Industry team involving resolution of Reactor Internals Cracking issues.

Lead Nuclear Steam Supply System Engineer 1989 – 1991

General management responsibility for 7-member NSSS engineering team.

Instituted cross training of areas of responsibility for engineers.

Shift Technical Advisor 1985 – 1989

Senior Reactor Operator licensed for Hope Creek.

UNITED STATES NUCLEAR NAVY **1975 – 1985**

EDUCATION

Rutgers, The State of University of New Jersey, Camden, NJ
Some courses taken for Masters of Business Administration

Pennsylvania State University, University Park, PA
Received BS in Nuclear Engineering

CERTIFICATES

Registered Professional Engineer in New Jersey

Enclosure 2

RESUME OF CURTIS L. BAGNALL

EDUCATION

B.A., Business Administration, Washington State University	1972
B.S., Electrical Engineering, Washington State University	1972

PROFESSIONAL REGISTRATIONS

Professional Engineer: Oregon, Washington

PROFESSIONAL EXPERIENCE

CH2M HILL, Inc.,	1972-Present
Project Manager	1974-Present
Client Service Manager	1980-Present
Department Manager	1988-1993
Discipline Group Director	1990-1994
Practice Director	1994-1996
Program Manager	1994-Present
Vice President	1996-Present

Mr. Bagnall has over 30 years of experience at CH2M Hill in planning, analysis, design and construction related to electric utility operations, power supply, transmission, distribution, financing and operations. His experience includes project management, feasibility, permitting and licensing, financing, contract negotiations, design, and services during construction for generation projects; transmission and distribution system planning, design and construction; cost-of-service, revenue requirements, and rate design; preparation of engineer's reports in support of bond sales for distribution, transmission and generation projects; and acting as the Owner's Engineer throughout project development. Mr. Bagnall also has extensive experience in the evaluation of renewable energy projects, including wind, solar, biomass and small hydroelectric development.

His experience includes:

- For the U.S. Army and Air Force, evaluated the technical and economic merits of individual combined heat and power systems, separate heat and power systems, and a regional heat and power system for three interior Alaska installations. This effort included a concept-level evaluation of potential approaches to generating electricity using present technologies and technologies expected to be commercially available in the next decade. The study included review of the operating issues associated with using intermittent resources to meet system electrical loads. This evaluation included assessing the potential for wind and solar power to meet the Army's electricity needs in interior Alaska. (2003-2004)

- For a California city, prepared an analysis of the feasibility of establishing a "solar power" utility. The analysis included a review of the use of photovoltaics to generate electricity, siting considerations, existing federal and state programs supporting the installation of solar power, available funding sources and support programs at the federal and state levels, review of programs offered by other cities, and a proforma economic analysis of the costs and expected savings for a solar utility. (2003)

- For the California Energy Commission, analyzed the technical and economic aspects of using landfill gas and dairy manure for the production of electricity. (2003-2005)

- Provided assistance to wind farm developers in the Pacific Northwest with obtaining transmission services for their wind farms and in negotiating transmission agreements. (2001-2002)

- Evaluated the desirability of continued operation of an existing gas-fired generation and steam heating plant when compared to a new power plant and a gas distribution/heating system. (2001)

- Acted as the Owner's Engineer on a 30 MW biomass fueled cogeneration project. Participated in the conceptual development of the project, development of contracts between the parties, the project financing efforts, design review, construction oversight, and is the ongoing Consulting Engineer for the project. (1993-2005)

- Negotiated long-term power purchase and sales contracts. (1990-1995)

- Acted as the Owner's Engineer on a 10 MW hydroelectric installation and as the overall Project Manager for a 5 MW hydroelectric installation. Both projects took advantage of fish ladder attraction water systems at existing Corps of Engineer dams on the Columbia River. For both projects, he was responsible for the feasibility studies, the licensing and permitting, and the Engineer's Report in support of bond sales. (1988-1996)

- Conducted numerous evaluations of small hydropower facilities. (1985-1994)

- Prepared electric distribution and transmission system plans for electric utilities to provide them with a schedule for improvement to the system because of load growth, system capacity constraints, and reliability considerations. This work included outage research and analysis, assessment of system condition and maintenance practices; review of distribution construction methods; load forecast preparation and review; load flow, fault, and stability analysis; improvement alternatives development, analysis and selection; and preparation of financial forecasting models. (1974-1995)

- Prepared cost-of-service and retail rate design studies for electric distribution system utilities. These studies have addressed wholesale power supply costs, transmission charges, and system costs of doing business. (1973-2002)

- Prepared engineer's reports in support of bond sales for distribution and transmission systems and power supply projects. These reports typically include a review of the system's condition; planned future improvements; management, administration and operations; reliability; and financial performance. (1973-2003)

Enclosure 3

Exelon. Nuclear

Exelon Nuclear
200 Exelon Way
KSA3-N
Kennett Square, PA 19348

Telephone 610.765.5610
Fax 610.765.5755
www.exeloncorp.com

52.17

September 23, 2004

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

Subject: Exelon Generation Company, LLC (EGC), Response to Requests for Additional Information (RAI) regarding the Environmental Portion of the Application for an Early Site Permit (ESP) (TAC NO. MC1125)

Re: Letter, U.S. Nuclear Regulatory Commission (T. J. Kenyon) to Exelon Generation Company, LLC, (M. Kray), dated August 23, 2004, Request for Additional Information (RAI) Regarding the Environmental Portion of the Early Site Permit Application for the Exelon Generation Company Site (TAC NO. MC1125)

Enclosed are:

(1) Revised response to RAI E3.8-4 regarding transportation of radioactive materials from gas-cooled reactors;

(2) Revised response to RAI E7.2-3 (f) regarding impacts of postulated accidents;

(3) Response to RAI E3.8-15 regarding the transportation of radioactive materials from light water reactors; and

(4) Response to RAI E9.2-1 regarding Clean Energy Alternatives.

Items (3) and (4) were requested in the referenced letter. Item (2) is provided to correct identified inconsistencies between the original response dated July 23, 2004 and the associated data. Item (1) is provided to incorporate consistent analysis assumptions for the gaseous and light water reactors.

Please contact Mr. Thomas Mundy of my staff at 610-765-5662 or me if you have any questions or comments regarding this submittal.

Sincerely yours,

Marilyn C. Kray

Marilyn C. Kray
Vice President, Project Development

MCK/TPM/wdm

cc: U.S. NRC Regional Office (w/ enclosures)
Mr. Thomas J. Kenyan (w/ enclosures)

Enclosures: (1) Revised response to RAIs E3.8-4 and E7.2-3 (f)

(2) Response to RAIs E3.8-15 and E9.2-1

AFFIDAVIT OF MARILYN C. KRAY

State of Pennsylvania

County of Chester

The foregoing document was acknowledged before me, in and for the County and State aforesaid, by Marilyn C. Kray, who is Vice President, Project Development, of Exelon Generation Company, LLC. She has affirmed before me that she is duly authorized to execute and file the foregoing document on behalf of Exelon Generation Company, LLC, and that the statements in the document are true to the best of her knowledge and belief.

Acknowledged and affirmed before me this 23rd day of September, 2004.

My commission expires Sept. 20, 2008.

Staci L. Sprouse
Notary Public

COMMONWEALTH OF PENNSYLVANIA
Notarial Seal
Staci L. Sprouse, Notary Public
Kennett Twp., Chester County
My Commission Expires Sept. 20, 2008
Member, Pennsylvania Association Of Notaries

NRC Letter Dated: 08/23/04

NRC RAI No. E9.2-1

E9.2-1 In its August 6, 2004, Memorandum and Order, the Atomic Safety and Licensing Board for the Exelon early site permit application admitted the following contention:

EC 3.1

The Clean Energy Alternatives Contention

CONTENTION: The Environmental Review fails to rigorously explore and objectively evaluate all reasonable alternatives. In Section 9.2 of the Environmental Report, Exelon claims to satisfy 10 CFR 51.45(b)(3), which requires a discussion of alternatives that is "sufficiently complete to aid the Commission in developing and exploring" "appropriate alternatives concerning alternative uses of available resource," pursuant to the National Environmental Policy Act. However, Exelon's analysis is premised on several material legal and factual flaws that lead it to improperly reject better, lower-cost, safer, and environmentally preferable wind power and solar power alternatives, and fails to address adequately a mix of these alternatives along with the gas-fired generation and "clean coal" resource alternatives. Therefore, Exelon's ER does not provide the basis for the rigorous exploration and objective evaluation of all reasonable alternatives to the ESP that is required by NEPA.

Provide information to address this contention.

EGC RAI ID: R15-2

EGC RESPONSE:

EGC has addressed the issues raised in the Contention. As a result, ER, Chapter 9, Section 9.2.2.1, Wind, Section 9.2.2.4, Solar, Section 9.2.4, Conclusion, Table 9.2-6, Impacts Comparison Summary, Table 9.2-7, Impacts Comparison Detail, and References for Section 9.2 will be revised. Section 9.2.3.3, Combination, Figure 9.2-3, Illinois Wind Resource Map, and Figure 9.2-4, Direct Normal Solar Radiation Map will be inserted.

ASSOCIATED EGC ESP APPLICATION REVISIONS:

Replace Chapter 9, Section 9.2.2.1 Wind with:

9.2.2.1 Wind

Wind resource maps usually identify areas by wind power class (See Figure 9.2-3). Although some midwestern states like North and South Dakota, as well as parts of Iowa, have excellent potential (Class 6 and above) for development of wind generation; the potential for generation is more intermittent in Illinois (ELPC, 2001).

In general, areas identified as Class 4 and above are regarded as potentially economical for wind energy production with current technology. The Department of Energy's Wind Program and National Renewable Energy Laboratory (NREL) wind resource maps for Illinois shows that there are scattered areas in central and northern Illinois with the classification of Class 4 with the total of these sites capable of 3000 MWe of potential installed capacity for wind generation. The most favorable of these sites are located southeast of Quincy, the greater Bloomington area, north of Peoria, the Mattoon area, and between Sterling and Aurora (USDOE/EERE, 2004b). EGC does not own or have rights to build a wind generating station on these sites.

At a Class 4 site, the average annual output of a wind power plant is typically about 25% of the installed capacity (USDOE/EERE, 2004b). For example, a wind farm on all of the land area identified as Class 4 by NREL within Illinois would generate an average annual output of 750 MWe. In fact, the National Electric Reliability Council (NERC) credits wind capacity at approximately 17% (USNRC, 2004). More optimistic assessments place the capacity factor for a Class 4 wind facility at about 29%, rising to 35% in 2020 based upon assumed improvements in technology (ELPC, 2001). However, even using such numbers would not affect the conclusions presented below (e.g., land usage per average MWe would decrease proportionately with increasing capacity factors, but would still be several times higher than the land usage for a nuclear plant.

As a result of advances in technology and the current level of financial incentive support within Illinois, a number of additional areas with a slightly lower wind resource (Class 3+) may also be suitable for wind development. These would, however, operate at an even lower annual capacity factor and output than that used by NREL for Class 4 sites.

In Illinois, the total amount of Class 4 and 3+ lands is about 1800 km2 (695 mi^2, or 444,800 acres) and the wind potential from these sites is about 9000 MWe of installed capacity (USDOE/EERE, 2004b).

In any wind facility, the land use could be significant. Wind turbines must be sufficiently spaced to maximize capture of the available wind energy. If the turbines are too close together, one turbine can impact the efficiency of another turbine. A 2 MWe turbine requires only about a quarter of an acre of dedicated land for the actual placement of the wind turbine; leaving landowners with the ability to utilize the remaining acreage for some other uses that do not impact the turbine, such as agricultural use.

For illustrative purposes, if all of the resource in Class 3+ and 4 sites were developed using 2 MWe turbines, with each turbine occupying one-quarter acre, 9000 MWe of installed capacity would utilize 1125 acres just for the placement of the wind turbines alone. Based upon the NERC capacity factor, this project would have an average output of 1530 MWe (approximately 0.73 acres / MWe). This is a conservative assumption since Class 3+ sites will have a lower percentage of average annual output, but it is being used here for illustrative purposes. In contrast, the EGC ESP Facility (operating at 90% capacity) would have an average annual output of 1962 MWe (2180 MWe * 0.9) and would only occupy approximately 461 acres (approximately 0.23 acres / MWe).

Although wind technology is considered mature, technological advances may make wind a more economic choice for developers than other renewables (CEC, 2003). Technological improvements in wind turbines have helped reduce capital and operating costs. In 2000, wind power was produced in a range of $0.03 - $0.06 / kWh (depending on wind speeds), but by 2020 wind power generating costs are projected to fall to $0.03 - $0.04 / kWh (ELPC, 2001).

The installed capital cost of a wind farm includes planning, equipment purchase and construction of the facilities. This cost, typically measured in $/kWe at peak capacity, has decreased from more than $2,500/kWe in the early 1980's to less than $1,000/kWe for wind farms in the U.S. Illinois Rural Electric Cooperative recently installed a single 1.65 MWe turbine at a cost of $1.7 million (Halstead, 2004). This cost includes the purchase of the turbine itself, construction of access roads and foundations, and connection to the transmission system. This decrease in construction costs is due primarily to improvements in wind turbine technology, but also to the general increase in wind farm sizes. Larger wind farms in windy areas benefit from economies of scale in all phases of a wind project from planning to decommissioning, as fixed costs can be spread over a larger total generating capacity. These "economies of scale" may not be available in the region of interest, given the availability of the resource (CEC, 2003).

As an example of cost, a wind generating facility that has an installed capacity of 75 MWe can produce power at a levelized rate of $0.049/kWh. With the Federal Production Tax Credit (PTC), the cost is reduced to $0.027 - $0.035/kWh. The PTC primarily reduced the tax burden and operating costs for wind generating facilities, which was vital to financing of facilities. The PTC expired in December 2003 and has not been renewed, even though it has support in the 2003 Energy Policy Act (U.S. Senate, 2003). As a result, a smaller number of completed wind projects in Illinois are anticipated. As the General Manager of the Illinois Rural Electric Cooperative explains "The energy bill stalled in Congress last fall, and still has not been passed, so right now there's not an authorization for production tax credits for new turbines. As a consequence, you're not going to have new turbines being installed by developers until that production tax credit returns. And the economics are such that you absolutely have to have a substantial body of grants and support as we do, and/or the production tax credits (Halstead, 2004)." As a tax credit, the PTC represented 1.8 cent per kWh of tax-free money to the project owner. If the owner did not receive the tax credit and wanted to recoup the 1.8 cents per kWh with taxable revenue from electricity sales, the owner would have to add at least 1.8 cents and possibly as much as 2.8 cents to the sales price of each kWh, assuming a 36-percent marginal tax rate.

The Energy Information Agency's (EIA) Annual Energy Outlook 2004 with projections to 2025 assumes no extension of the PTC beyond 2003. Further, the EIA projects that the levelized cost of electricity generated by wind plants coming on line in 2006 (over a 20-year financial project life) would range from approximately 4.5 cents per kilowatthour at a site with excellent wind resources to 5.7 cents per kilowatthour at less favorable sites (USDOE/EIA, 2004a). In contrast, the levelized cost for electricity from new natural gas combined-cycle plants is 4.7 cents per kWh, and for new coal-fired plants, the projected cost in 2007 is 4.9 cents per kWh (USDOE/EIA, 2004a). Nuclear plants are anticipated to produce power in the range of 3.1 to 4.6 cents per kWh (USDOE, 2002) (USDOE, 2004).

In addition to the construction and operating and maintenance costs for wind farms, there are costs for connection to the transmission grid. Any wind project would have to be located where the project would produce economical generation 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 will be required to connect the wind farm to the distribution system. Existing transmission infrastructure may need to be upgraded to handle the additional supply. Soil conditions and the terrain must be suitable for the construction of the towers' foundations. Finally, the choice of a location may be limited by land use regulations and the ability to obtain the required permits from local, regional and national authorities. The further a wind energy development project is from transmission lines, the higher the cost of connection to the transmission and distribution system. A recent report to Congress on wind resource locations and transmission requirements in the upper Midwest (Upper Midwest for this report was defined as the States of North and South Dakota, Minnesota, Illinois, Iowa, Nebraska, and Wisconsin) concluded, "Transmission in the upper Midwest is generally constrained. In addition, because power generation is often transmitted over long distances to metropolitan centers, the upper Midwest has voltage and stability issues that must be considered. Since it is more economic to transmit wind from remote areas, developing more wind energy in remote areas may aggravate these voltage and stability issues (USDOE/EERE, 2004a)." In contrast, the EGC ESP site is located in southern Illinois, and is located near interties with the adjoining transmission systems.

The distance from transmission lines at which a wind developer can profitably build depends on the cost of the specific project. Consider, for example, the cost of construction and interconnection for a 115-kV transmission line that would connect a 50 MWe wind farm with an existing transmission and distribution network. The EIA estimated, in 1995, the cost of building a 115-kV line to be $130,000 per mile, excluding right-of-way costs (USDOE/EIA, 2004b). This amount includes the cost of the transmission line itself and the supporting towers. It also assumes relatively ideal terrain conditions, including fairly level and flat land with no major obstacles or mountains (More difficult terrain would raise the cost of erecting the transmission line.). In 1993, the cost of constructing a new substation for a 115-kV transmission line was estimated at $1.08 million and the cost of connection for a 115-kilovolt transmission line with a substation was estimated to be $360,000 (USDOE/EIA, 1995).

In 1999, the USDOE analyzed the total cost of installing a wind facility in various NERC regions. They first looked at the distribution of wind resources and excluded land from development based on the classification of land. For example, land that is considered wetlands and urban are totally excluded whereas land that is forested has 50% of its land excluded. They then characterized those resources that were sufficiently close to existing 115- to 230-kilovolt transmission lines, classified them into three distance zones, and applied an associated standard transmission fee for connecting the new plant with the existing network. They then used additional cost factors to account for the greater distances between wind sites and the existing transmission networks. Capital costs were added based on whether the wind resource was technically accessible now and whether it could be economically accessible by 2020. Based on this USDOE analysis, Illinois has no known economically useful wind resources (USDOE/EIA 1999a).

Another consideration on the integration of the wind capacity into the electric utility system is the variability of wind energy generation. Wind-driven electricity generating facilities must be located at sites with specific characteristics to maximize the amount of wind energy captured and electricity generated (ELPC, 2001). In addition, for transmission purposes, wind generation is not considered "dispatchable," meaning that the generator can control output to match load and economic requirements. Since the resource is intermittent, wind, by itself, is not considered a firm source of baseload capacity. The inability of wind alone to be a dispatchable, baseload producer of electricity is inconsistent with the objectives for the EGC ESP Facility.

Finally, wind does have environmental impacts, in addition to the land requirements posed by large facilities. First, some consider large-scale commercial wind farms to be an aesthetic problem. In one case, residents opposing the Cordelia Hills wind project in Solano County, northeast of San Francisco, reportedly did not want to see turbines sited nearby, even though the hills chosen for the project already had numerous electronic relays and transmission lines. Aesthetic impacts were also a key factor behind opposition to wind development at Tejon Pass, one of the most scenic areas close to Los Angeles (NWCC, 1997). Second, high-speed wind turbine blades can be noisy, although technological advancements continue to lessen this problem. Finally, wind facilities sited in areas of high bird use can expect to have fatality rates higher than those expected if the wind facility was not there. Water within the vicinity of wind turbines, such as sites around the Great Lakes, may attract waterfowl and shorebirds, increasing the collision potential for water bird species, although other factors such as adjacent habitats and movement patterns would also greatly influence mortality near these water sources (NWCC, 2001). Land use and aesthetic impacts could be moderate to large, while other impacts to human health and the environment would be small. The environmental impacts of wind power are discussed in more detail in Table 9.2-7.

9.2.2.1.2 Summary

EGC has concluded that, due to the inability of wind power to generate baseload power, the projected land use impacts of development of Class 3+ and Class 4 sites in Illinois, the cost factors in construction and operation, along with the impacts associated with development, and cost of additional transmission facilities to connect all of these turbines to the transmission system, wind by itself is not a feasible alternative to the EGC ESP.

Wind power could be included in a combination of alternatives to the EGC ESP. The study of combinations is discussed in Section 9.2.3.3.

Replace Chapter 9, Section 9.2.2.4 Solar with:

9.2.2.4 Solar Power

Solar energy is dependent on the availability and strength of sunlight (strength is measured as kWh/m^2). Solar power is considered an intermittent source of energy. This section addresses solar power alone and only those solar technologies capable of being connected to a transmission grid. Combinations of solar power with other generating sources are discussed in Section 9.2.3.3.

Solar power is not generally considered a baseload source. Storage technologies have not advanced to a point where solar power can be considered as feasible alternatives to large baseload capacity (USDOE/EERE, 2004e). However, all solar technologies provide a fuel-saving companion to a baseload source. These technologies can be divided into two groups. The first group concentrates the sun's energy to drive a heat engine (concentrating solar power systems). The other group of solar power technologies directly converts solar radiation into electricity through the photoelectric effect by using photovoltaics (also known as PV).

In Illinois, solar energy varies from 4-5 $kWh/m^2/day$ in the summer to as low as 2-3 $kWh/m^2/day$ the winter. (See Figure 9.2-4). The areas with the highest amount of solar radiation are in the southwestern part of the state, with radiation rates of 6 - 7 kWh/m^2 at the brightest time of a summer day, but most of Illinois falls in the range of 5.5 - 6 kWh/m^2. This resource is relatively low, particularly when compared to the southwestern United States. For example, parts of southern California can generate 10 - 12 kWh/m^2 of solar radiation during the brightest part of summer days. From a national resource availability perspective, then, it can be seen that the region of interest is not an attractive location for development of solar power. In addition to the relatively low amount of solar resource available, solar radiation varies by month (USDOE/NREL, 2004c). Solar energy also has a definite diurnal characteristic-the sun does not shine at night. Recognizing the comparative "abundance" of solar energy in the region of interest and the intermittent nature of solar-based electricity generation, various solar technologies are discussed below.

9.2.2.4.1 Concentrating Solar Power Systems

Concentrating solar power plants only perform efficiently in very sunny locations, specifically the arid and semi-arid regions of the world (USDOE/EERE, 1999).This does not include Illinois.

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

Concentrating solar power systems can be sized for 'village' power (10 kW) or grid-connected applications (up to 100 MW). Some systems use thermal energy storage (TES), setting aside heat transfer fluid in its hot phase during cloudy periods or at night. These attributes, along with solar-to-electric conversion efficiencies, make concentrating solar power an attractive renewable energy option in the Southwest of the United States and other Sunbelt regions worldwide (USDOE/EERE, 2004d). Others can be combined with natural gas. This type of combination of is discussed in Section 9.2.3.3.

There are three kinds of concentrating solar power systems—troughs, dish/engines, and power towers—classified by how they collect solar energy (USDOE/EERE, 2004d). Each is briefly discussed below.

Trough systems: The sun's energy is concentrated by parabolically curved, trough-shaped reflectors onto a receiver pipe running along the inside of the curved surface. This energy heats oil flowing through the pipe and the heat energy is then used to generate electricity in a conventional steam turbine generator.

A collector field comprises many troughs in parallel rows aligned on a north-south axis. This configuration enables the single-axis troughs to track the sun from east to west during the day to ensure that the sun is continuously focused on the receiver pipes. Individual trough systems currently can generate about 80 MWe. Experimental trough systems in California can currently generate approximately 300 MWe.

Current storage capacity at trough plants is minimal – most plant only have a storage capacity of 25%. Trough designs can incorporate TES allowing for electricity generation several hours into the evening. Currently, all parabolic trough plants are "hybrids," meaning they use fossil-fueled generation to supplement the solar output during periods of low solar radiation. This type of combination is discussed in Section 9.2.3.3.

Dish/engine systems: A dish/engine system is a stand-alone unit composed primarily of a collector, a receiver, and an engine. The sun's energy is collected and concentrated by a dish-shaped surface onto a receiver that absorbs the energy and transfers it to the engine's working fluid. The engine converts the heat to mechanical power in a manner similar to conventional engines—that is, by compressing the working fluid when it is cold, heating the compressed working fluid, and then expanding it through a turbine or with a piston to produce work. The mechanical power is converted to electrical power by an electric generator or alternator.

Dish/engine systems use dual-axis collectors to track the sun. The ideal concentrator shape is parabolic, created either by a single reflective surface, multiple reflectors, or facets. Many options exist for receiver and engine type, including Stirling engine and Brayton receivers.

Dish/engine systems are not commercially available yet, although ongoing demonstrations indicate the potential for commercial viability. Individual dish/engine systems currently can generate about 25 kilowatts of electricity. More capacity is possible by connecting dishes together. These systems can be combined with natural gas generation and the resulting hybrid provides continuous power generation. This type of combination is discussed in Section 9.2.3.3.

Power tower systems: The sun's energy is concentrated by a field of hundreds or even thousands of mirrors (called "heliostats") onto a receiver located on top of a tower. This energy heats molten salt flowing through the receiver, and the salt's heat energy is then used to generate electricity in a conventional steam turbine generator. The molten salt retains heat efficiently, so it can be stored for hours or even days before it loses its capacity to generate electricity. Solar Two, a demonstration power tower located in the Mojave Desert in California, generated about 10 MW of electricity before the project was discontinued in 1999.

In these systems, the molten salt at 550°F is pumped from a "cold" storage tank through the receiver, where it is heated to 1,050°F and then on to a "hot" tank for storage. When power is needed from the plant, hot salt is pumped to a steam generating system that produces steam to power a turbine generator. From the steam generator, the salt is returned to the cold tank, where it is stored and eventually reheated in the receiver.

With TES, power towers can operate at an annual capacity factor of 65%, which means they can potentially operate for 65% of the year without the need for a back-up fuel source. Without energy storage, solar technologies like this are limited to annual capacity factors near 25%. The power tower's ability to operate for extended periods of time on stored solar energy separates it from other solar energy technologies.

Concentrating solar energy systems have a close resemblance to most power plants operated by the nation's power industry and their ability to provide central generation. Concentrating solar power technologies utilize many of the same technologies and equipment used by conventional power plants, simply substituting the concentrated power of the sun for the combustion of fossil fuels to provide the energy for conversion into electricity. This "evolutionary" aspect—as distinguished from "revolutionary" or "disruptive"—allows for easy integration into the transmission grid. It also makes concentrating solar power technologies the most cost-effective solar option for the production of large-scale electricity generation (10 MWe and above).

While concentrating solar power technologies currently offer the lowest-cost solar electricity for large-scale electricity generation, these technologies are still in the demonstration phase of development and cannot be considered competitive with fossil- or nuclear-based technologies (CEC, 2003). Current technologies cost 9 cents-12 cents per kilowatt-hour (kWh). New innovative hybrid systems that combine large concentrating solar power plants with conventional natural gas combined cycle or coal plants can reduce costs to $1.5 per watt and drive the cost of producing electricity from solar power to below 8 cents per kWh (USDOE/EERE, 2004d). This type of combination is discussed in Section 9.2.3.3. Future advances are expected to allow electricity from solar power to be generated for 4 cents-5 cents per kWh in the next few decades (USDOE/EERE, 2004d). In contrast, nuclear plants are anticipated to produce power in the range of 3.1 to 4.6 cents per kWh (USDOE, 2002) (USDOE, 2004).

9.2.2.4.2 Photovoltaic Cells

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

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

"Flat-plate" PV arrays can be mounted at a fixed-angle facing south, or they can be mounted on a tracking device that follows the sun, allowing them to capture more sunlight over the course of a day. Ten to 20 PV arrays can provide enough power for a household; for large electric utility or industrial applications, hundreds of arrays can be interconnected to form a single, large PV system (USDOE/EERE, 2004b). According to USDOE estimates, land use for this technology is approximately 2.5 ac to 12 ac/MWe (USDOE/NREL, 2004b).

Some PV cells are designed to operate with concentrated sunlight, and a lens is used to focus the sunlight onto the cells. This approach has both advantages and disadvantages compared with flat-plate PV arrays. Economics of this design turns on the use of as little of the expensive semiconducting PV material as possible, while collecting as much sunlight as possible. The lenses cannot use diffuse sunlight, but must be pointed directly at the sun and move to provide optimum efficiency. Therefore, the use of concentrating collectors is limited to the west and southwest areas of the country. According to the USDOE estimates, land use for this method is approximately 5 ac to 12 ac/MWe (USDOE/NREL, 2004a).

Available photovoltaic cell conversion efficiencies are in the range of approximately 15 percent (15%) (Siemens, 2004). The average solar energy falling on a horizontal surface in the Illinois region in June, a peak month for sunlight, is approximately 4 to 5 kWh/m^2 per day (USDOE/EERE, 2004b). If an average solar energy throughout the year of approximately 5 kWh/m^2 per day and a conversion efficiency of 15% were used, photovoltaic cells would yield an annual electricity production of approximately 274 kWh/m^2 per year in Illinois. At this rate of generation, generating base-loaded electricity equivalent to the EGC ESP Facility would require approximately 62,726,715 m^2 (2180 MWe (See ER Sec. 3.7.2) *0.9 * 8760 hr/yr * 1000 kW/MW / 274 $kWh/m^2/yr$) or approximately 63 km^2 (24 mi^2) of PV arrays.

The same values that drive the PV system market also set the wide range of PV costs. The high range of capital costs of $5 to $12 per watt is offset by low operating costs, measured in kWh. The 20-year life-cycle cost ranged from 20 cents to 50 cents per kWh (USDOE/EERE, 2004f).

Currently photovoltaic solar power is not competitive with other methods of producing electricity for the open wholesale electricity market. When determining the cost of solar systems, the totality of the system must be examined. There is the price per watt of the solar cell, price per watt of the module (whole panel), and the price per watt of the entire system. It is important to remember that all systems are unique in their quality and size, making it difficult to make broad generalizations about price. The average PV cell price was $2.40 per peak watt in 2000 and the average per peak watt cost of a module was $3.46 in the same year (USDOE/EIA, 1999). The module price however does not include the design costs, land, support structure, batteries, an inverter, wiring, and lights/appliances. With all of these included, a full system can cost anywhere from $7 to $20 per watt (Fitzgerald, 2004). Costs of PV cells in the future may be expected to decrease with improvements in technology and increased production. Optimistic estimates are that costs of grid-connected PV systems could drop to $2,275 per kW and to $0.15 to $0.20 per kWh by 2020 (ELPC, 2001). These costs would still be substantially in excess of the costs of power from a new nuclear plant.

9.2.2.4.3 Environmental Impacts

Land use and aesthetics are the primary environmental impacts of solar power. Land requirements for each of the individual solar energy technologies is large, compared to the land used for the EGC ESP Facility. The land required for the solar generating technologies discussed here ranges from 3 to 12 ac/MWe compared to 0.23 acres per MWe for nuclear. In addition, this land use is pre-emptive; land used for solar facilities would not be available for other uses such as agriculture.

Depending on the solar technology used, there may be thermal discharge impacts. These impacts are anticipated to be small. During operation, PV and solar thermal technologies produce no air pollution, little or no noise, and require no transportable fuels.

There are environmental impacts of PV related to manufacture and disposal. The process to manufacture PV cell is similar to the production of a semiconductor chip. Chemicals used in the manufacture of PV cells include cadmium and lead. Potential human health risks also arise from the manufacture and deployment of PV systems, since there is a risk of exposure to heavy metals such as selenium and cadmium during use and disposal (CEC, 2004). There is some concern that landfills could leach cadmium, mercury, and lead into the environment in the long term. Generally, PV cells are sealed and the risk of release is considered slight, however, the long-term impact of these chemicals in the environment is unknown. Another environmental consideration with solar technologies is the lead-acid batteries that are used with some systems. The impact of these lead batteries is lessening however as batteries become more recyclable, batteries of improved quality are produced and better quality solar systems that enhance battery lifetimes are created (Real, et. al., 2001).

9.2.2.4.4 Summary

Solar power alone cannot be used to generate baseload power, because of the intermittent nature of the resource. Therefore, solar power alone is not a reasonable alternative to the baseload generating facility being considered for the Clinton site. Solar power in combination with storage facilities (e.g., power troughs with molten salt storage) can be used to generate baseload power. However, such a facility is still in the developmental stage, and such facilities (and solar facilities in general) are not economically competitive alternatives to the proposed EGC ESP Facility because the resource is intermittent and incoming solar radiation is low for most of the year throughout the region of interest. Additionally, there are potential environmental impacts associated with any large-scale solar generation facilities. Land use and aesthetic impacts would most likely be large compared to a nuclear plant.

The solar resource could contribute to a competitive combination of alternative energy sources. This combination of alternatives is discussed in Section 9.2.3.3.

Insert new Chapter 9, Section 9.2.3.3 Combination of Alternatives:

9.2.3.3 Combination of Alternatives

This section examines combinations of alternatives that could generate baseload power in an amount equivalent to the proposed EGC ESP Facility.

As discussed in Section 9.2.2.1, the capacity of the EGC ESP facility is 2180 MWe, with an annual energy output of about 17,200,000 MWh. There are a number of combinations of alternatives that have the potential of producing this baseload capacity and output.

Because of the intermittent nature of the resource and the lack of cost-effective technology, wind and solar are not sufficient on their own to generate the equivalent baseload capacity or output of the EGC ESP Facility, as discussed in Section 9.2.2.1 and 9.2.2.4. As shown in Sections 9.2.3.1 and 9.2.3.2, fossil-fired generation generates baseload capacity, but environmental impacts are greater than the EGC ESP Facility. It is conceivable, however, that a combination of alternatives (renewables in combination with fossil-fired generation) might be cost-effective and have less environmental impact than the EGC ESP Facility.

There is a multitude of possible combinations when considering the power sources and the output of each source. For the renewal of licenses pursuant to 10 CFR, Part 54, the NRC has already determined that expansive consideration of combinations would be too unwieldy given the purposes of the alternative analysis (USNRC, 1996). However, the combination alternative analysis should be sufficiently complete to aid the Commission in its analysis of alternative sources of energy pursuant to the National Environmental Policy Act (NEPA). The following analysis provides the basis for an evaluation of a reasonable combination of alternative energy sources to the EGC ESP Facility that is required by NEPA.

9.2.3.3.1 Determination of Alternatives

Many possible combinations of alternatives could satisfy the baseload capacity requirements of the EGC ESP Facility. Some combinations can include renewable sources, such as wind and solar. As discussed earlier in Section 9.2.2.1 and 9.2.2.4, wind and solar do not, by themselves, provide a reasonable alternative energy source to the baseload power to be produced by the EGC ESP Facility. However, wind and solar, in combination with fossil fuel-fired plant(s), may be a reasonable alternative to nuclear energy produced by the EGC ESP Facility.

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

When examining a combination of alternatives that would meet the business objectives similar to that of the EGC ESP Facility, any combination that includes a renewable power source (either all or part of the capacity of the EGC ESP Facility) must be combined with a fossil-fueled facility equivalent to the generating capacity of the EGC ESP Facility. This combination would allow the fossil-fueled portion of the combination alternative to produce the needed power if the renewable resource is unavailable and to be displaced when the renewable resource is available. For example, if the renewable portion is some amount of potential wind generation and that resource became available, then the output of the fossil-fueled generation portion of the combination alternative could be lowered to offset the increased generation from the renewable portion. This facility, or facilities, would satisfy business objectives similar to those of the EGC ESP Facility in that it would be capable of supporting fossil-fueled baseload power.

Coal - and gas – fired generation facilities have been examined in Sections 9.2.3.1 and 9.2.3.2, respectively, as having environmental impacts that are equivalent to or greater than the impacts of the EGC ESP facility. Based on the comparative impacts of these two technologies, as shown in Table 9.2-6, it can be concluded that a gas-fired facility would have less of an environmental impact than a comparably sized coal-fired facility. In addition, the operating characteristics of gas-fired generation are more amenable to the kind of load changes that may result from inclusion of renewable generation such that the baseload generation output of 2180 MWe is maintained. "Clean Coal" power plant technology could decrease the air pollution impacts associated with burning coal for power. Demonstration projects show that clean coal programs reduce NO_x, SO_x, and particulate emissions. However, the environmental impacts from burning coal using these technologies, if proven, are still greater than the impacts from natural gas (USDOE/NETL, 2001). Therefore, for the purpose of examining the impacts from a combination of alternatives to the EGC ESP Facility, a facility equivalent to that described in Section 9.2.3.2 (gas-fired generation) will be used in the environmental analysis of combination alternatives. The analysis accounts for the reduction in environmental impacts from a gas-fired facility when generation from the facility is displaced by the renewable resource. The impact associated with the combined-cycle natural gas-fired unit is based on the gas-fired generation impact assumptions discussed in Section 9.2.3.2. Additionally, the renewable portion of the combination alternative would be any combination of renewable technologies that could produce power equal to or less than the EGC ESP Facility at a point when the resource was available. The environmental impacts associated with wind and solar generation schemes are outlined in Sections 9.2.2.1 and 9.2.2.4, respectively. This combination of renewable energy and natural gas fired generation represents a viable mix of non-nuclear alternative energy sources.

For the purpose of the economic comparison of a combination of alternatives, a coal plant in combination with the renewable resource was analyzed. Coal is used for the purposes of the economic comparison because coal plants generate power at a lower cost than gas plants.

9.2.3.3.2 Environmental Impacts

The environmental impacts associated with a gas-fired facility sized to produce power equivalent to the EGC ESP Facility have already been analyzed in Section 9.2.3.2. Depending on the level of potential renewable output included in the combination alternative, the level of impact of the gas-fired portion will be comparably lower. If the renewable portion of the combination alternative were not enough to displace the power produced by the fossil fueled facility, then there would be some level of impact associated with the fossil fueled facility. Consequently, if the renewable portion of the combination alternative were enough to fully displace the output of the gas-fired facility, then, when the renewable resource is available, the output of fossil fueled facility could be eliminated, thereby eliminating its operational impacts. The lower the output of the renewable portion of the combination alternative, the closer the impacts approach the level of impact described in Section 9.2.3.2 for gas-fired generating facilities.

Determination of the types of environmental impacts of these types of 'hybrid' plants or combination of facilities can be surmised from analysis of past projects.

For instance, in 1984, Luz International, Ltd. built the Solar Electric Generating System (SEGS) plant in the California Mojave Desert. The SEGS technology consists of modular parabolic-trough solar collector systems, which use oil as a heat transfer medium. One unique aspect of the Luz technology is the use of a natural-gas-fired boiler as an oil heater to supplement the thermal energy from the solar field or to operate the plant independently during evening hours. SEGS I was installed at a total cost of $62 million (~$4,500/kW) and generates power at 24 cents/kWh (in 1988 real levelized dollars). The improvements incorporated into the SEGS III-VI plants (~$3,400/kW) reduced generation costs to about 12 cents/kWh, and the third-generation technology, embodied in the 80-MW design at an installed cost of $2,875/kW, reduced power costs still further, to 8-10 cents/kWh. Because solar energy is not a concentrated source the dedicated land requirement for the Luz plants is large compared to conventional plants--on the order of 5 ac/MW (2 ha/MW) (USDOE/NREL, 2004a), compared to 0.23 acres per MWe for a nuclear plant.

In Illinois, the solar thermal source is approximately 4.5 kWh/m^2; the SEGS units were built in an area of where the solar source is 5.5 kWh/m^2. Using the above metrics for land use and the solar source of 4.5 kWh/m^2 per day in Illinois, a similar SEGS unit within the region of interest would require dedicated land of approximately 6 acres/MWe (USDOE/EERE, 2004d), compared to 0.23 acres per MWe for a nuclear plant. Land use for generating baseload equivalent to the EGC ESP Facility would require approximately 13,000 acres (20 mi^2)(2180 MWe *6 acres/MW). Additionally, given the lower thermal source in Illinois, the capital costs for the solar portion of the hybrid plant would be proportionally greater than for the SEGS.

In the case of parabolic trough plants, all plants of this type of solar technology are configured in combination with a fossil fueled generation component. A typical configuration is a natural gas-fired heat or a gas steam boiler/reheater coupled to the trough system. Troughs also can be integrated with existing coal-fired plants. With the current trough technology, annual production nationwide is about 100 kWh/m^2 (USDOE/EERE, 2004c). Parabolic trough plants require a significant amount of land; typically the use is preemptive because parabolic troughs require the land to be graded level. A report, developed by the California Energy Commission (CEC), notes that 5 to 10 acres per MWe is necessary for concentrating solar power technologies such as trough systems (CEC, 2004).

The environmental impacts associated with a solar and a wind facility equivalent to the EGC ESP Facility have already been analyzed in Sections 9.2.2.1 and 9.2.2.4, respectively. It is reasonable to expect that the impacts associated with an individual unit of a smaller size would be similarly scaled. None of the impacts would be greater than those discussed in Sections 9.2.2.1 and 9.2.2.4. If the renewable portion of the combination alternative is unable to generate an equivalent amount of power as the EGC ESP Facility, then the combination alternative would have to rely on the gas-fired portion to meet the equivalent capacity of the EGC ESP Facility. Consequently, if the renewable portion of the combination alternative has a potential output that is equal to that of the EGC ESP Facility, then the impacts associated with the gas-fired portion of the combination alternative would be lower but the impacts associated with the renewable portion would be greater. The greater the potential output of the renewable portion of the combination alternative, the closer the impacts would approach the level of impact described in Sections 9.2.2.1 and 9.2.2.4.

The environmental impacts associated with a gas-fired facility and equivalent renewable facilities are shown in Table 9.2-7 and summarized in Table 9.2-6. The gas-fired facility alone has impacts that are larger than the EGC ESP Facility; some environmental impacts of renewables are also greater than or equal to the EGC ESP Facility.

The combination of a gas-fired plant and wind or solar facilities would have environmental impacts that are equal to or greater than those of a nuclear facility.

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

Therefore the combination of wind and solar facilities and gas-fired facilities is not environmentally preferable to the EGC ESP Facility.

9.2.3.3.3 Economic Comparison

As noted earlier the combination alternative must generate power equivalent to the capacity of the EGC ESP Facility. The USDOE has estimated the cost of generating electricity from a gas-fired facility (4.7 cents per kWh), a coal facility (4.9 cents per kWh), as well as wind (5.7 cents per kWh for sites similar to those in the region of interest), and solar (4 – 5 cents per kWh). The cost for gas-fired facility in combination with a renewable facility would increase, because the facility would not be operating at full availability when it is displaced by the renewable resource. As a result, the capital costs and fixed operating costs of the gas facility would be spread across fewer kWh from the gas facility, thereby increasing its cost per kWh. The projected cost associated with the operation a new nuclear facility similar to the EGC ESP Facility is in the range of 3.1 to 4.6 cents per kWh (USDOE, 2002) (USDOE, 2004). The projected costs associated with all other forms of generation other than the EGC ESP Facility are greater than the

EGC ESP Facility. Therefore, the cost associated with the operation of the combination alternative would not be competitive with the EGC ESP Facility.

9.2.3.3.4 Summary

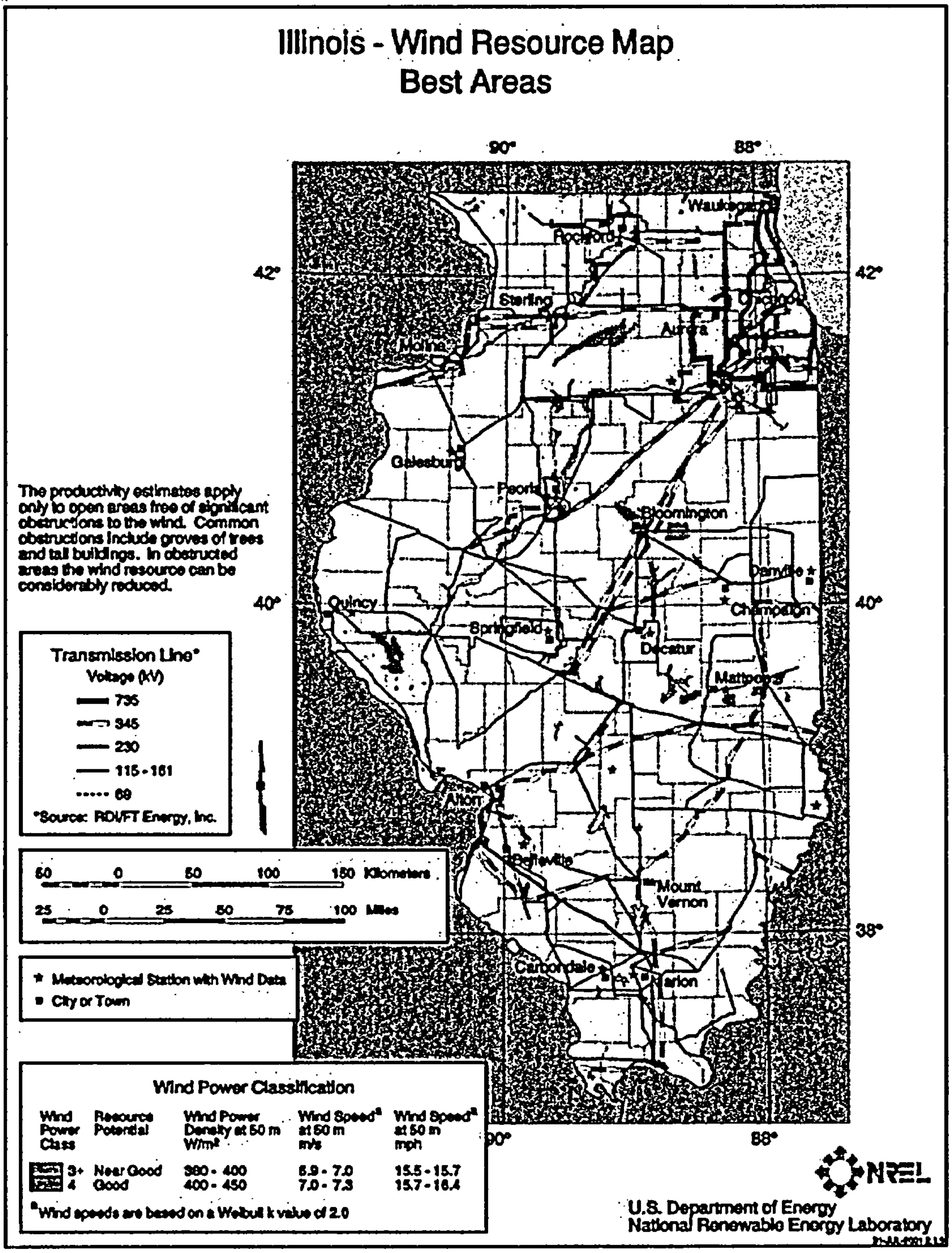
Wind and solar facilities in combination with fossil facilities could be used to generate baseload power and would serve the purpose of the EGC ESP Facility. However, wind and solar facilities in combination with fossil facilities would have equivalent or greater environmental impacts relative to a new nuclear facility at the EGC ESP Site. Similarly, wind and solar facilities in combination with fossil facilities would have higher costs than a new nuclear facility at the EGCESP Site. Therefore, wind and solar facilities in combination with fossil facilities are not preferable to the EGC ESP Facility.

Replace Chapter 9, Section 9.2.4 Conclusion with:

9.2.4 Conclusion

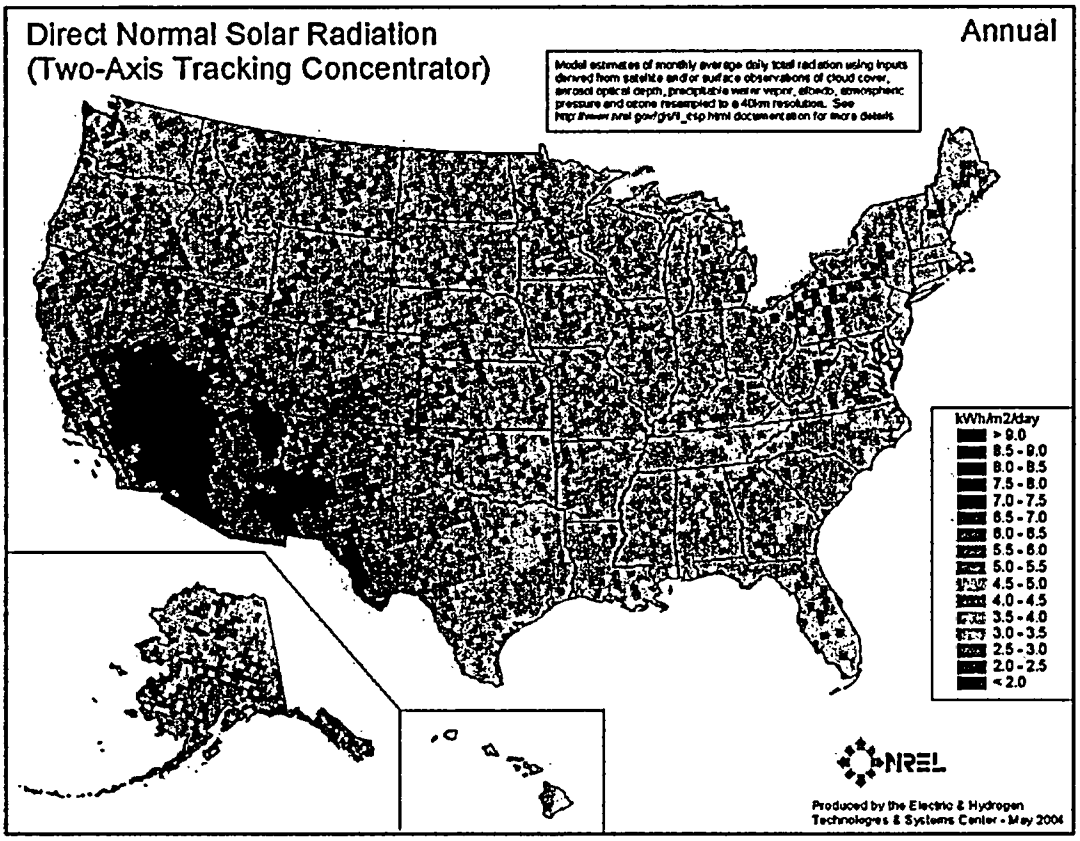
As shown in detail in Tables 9.2-6 and 9.2-7, based on environmental impacts, EGC has determined that neither a coal-fired, nor a gas-fired, nor a combination of alternatives, including wind and solar facilities, would provide an appreciable reduction in overall environmental impact relative to a nuclear plant. Furthermore, each of these types of alternatives, with the possible exception of the combination alternative, would entail a significantly greater environmental impact on air quality than would a nuclear plant. To achieve the small air impact in the combination alternative, however, a moderate to large impact on land use would be needed. Therefore, EGC concludes that neither a coal-fired, nor a gas-fired, nor a combination of alternatives would be environmentally preferable to a nuclear plant. Furthermore, these alternatives would have higher economic costs, and therefore are not economically preferable to a nuclear plant.

Insert new Figure 9.2-3, Illinois Wind Resource Map:



Source: (USDOE/EERE, 2004d)

Insert new Figure 9.2-4, Direct Normal Solar Radiation Map:



Source: (USDOE/NREL, May 2004c)

Replace Chapter 9, Table 9.2-6 Impacts Comparison Summary with:

Table 9.2-6
Impacts Comparison Summary

Impact Category	Proposed Action (EGC ESP)	Coal-Fired Generation	Gas-Fired Generation	Combinations
Land Use	Small	Small	Small	Small to Large
Water Quality	Small	Small	Small	Small
Air Quality	Small	Moderate to Large	Moderate	Small to Moderate
Ecological Resources	Small	Small	Small	Small
Threatened and Endangered Species	Small	Small	Small	Small
Human Health	Small	Moderate	Small	Small
Socioeconomics	Small	Small	Small	Small
Waste Management	Small	Moderate	Small	Small
Aesthetics	Small	Small	Small	Small to Large
Cultural Resources	Small	Small	Small	Small
Accidents	Small	Small	Small	Small

Notes: SMALL – Environmental effects are not detectable or are so minor that they will neither destabilize not 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.
10 CFR 51, Subpart A, Appendix B, Table B-1, Footnote 3.

Replace Chapter 9, Table 9.2-7 Impacts Comparison Detail with:

Table 9.2-7
Impacts Comparison Detail

Proposed Action (EGC ESP)	Coal-Fired Generation	Gas-Fired Generation	Combination
EGC ESP for 20 years, followed by construction, operation, and decommissioning.	New construction at the CPS site.	New construction at the CPS site.	New construction at the CPS site and construction for solar/wind installations throughout region of interest.
Upgrade existing switchyard and transmission lines.	Upgrade existing switchyard and transmission lines.	Upgrade existing switchyard and transmission lines.	Upgrade existing switchyard and transmission lines. Construction of transmission and rights-of-way for renewable generation.
	Upgrade existing rail spur.	Construct 2.5 miles of gas pipeline along existing rights-of-way.	Construct 2.5 miles of gas pipeline along existing rights-of-way.

Proposed Action (EGC ESP)	Coal-Fired Generation	Gas-Fired Generation	Combination
	Four 550-MW tangentially-fired, dry bottom units; capacity factor 0.85.	Four 550-MW units, each consisting of two 184-MW combustion turbines and a 182-MW heat recovery boiler; capacity factor 0.85.	Four 550-MW units, each consisting of two 184-MW combustion turbines and a 182-MW heat recovery boiler; capacity factor 0.85 maximum and probably less depending upon the amount of generation by renewable sources. Renewable energy sources: combination of solar and wind turbine technologies to produce up to 2180 MWe when resource is available.
New cooling water system with potential construction of new cooling towers.	New cooling water system with potential construction of new cooling towers.	New cooling water system with potential construction of new cooling towers.	New cooling water system with potential construction of new cooling towers. Depending on solar technology utilized, cooling water may also be needed.

Proposed Action (EGC ESP)	Coal-Fired Generation	Gas-Fired Generation	Combination
	Pulverized bituminous coal, 9,648 Btu/pound; 10,200 Btu/kWh; 6.9% ash; 1.01% sulfur; 9.7 pound/ton nitrogen oxides; 8,470,288 tons coal/yr.	Natural gas, 1,021 Btu/ft^3; 6,120 Btu/kWh; 0.0034 lb sulfur/MMBtu; 0.0109 lb NO_x/MMBtu; 102,118,571,753 ft^3 gas/yr.	Natural gas, 1,021 Btu/ft^3; 6,120 Btu/kWh; 0.0034 lb sulfur/MMBtu; 0.0109 lb NO_x/MMBtu; 102,118,571,753 ft^3 gas/yr when operating at capacity mentioned above. Effluents would be scaled based on level of renewable generation.
	Low NO_x burners, overfire air, and selective catalytic reduction (95% NO_x reduction efficiency).	Selective catalytic reduction with steam/water injection.	Selective catalytic reduction with steam/water injection.
	Wet scrubber – lime desulfurization system (95% SO_x removal efficiency); 149,512 tons limestone/yr.		
	Fabric filters (99.9% particulate removal efficiency.		
580 workers	250 workers	25-40 workers	40-50 workers

Proposed Action (EGC ESP)	Coal-Fired Generation	Gas-Fired Generation	Combination	
			Gas-fired	Renewable
		Land Use Impacts		
SMALL – Construction at CPS would be in previously disturbed areas. Facility would consist of approximately 150 acres.	SMALL – Construction at CPS would be in previously disturbed areas. The plant would upgrade existing rail spur and use transportation corridors. Forty years of ash and scrubber waste disposal would require 234 acres and construction of the power block and coal storage areas would impact approximately 200 acres.	SMALL – Construction at CPS would be in previously disturbed areas. 110 acres for facility; pipeline could be routed along existing rights-of-way and would require an additional 40 acres for easement.	SMALL – Construction at CPS would be in previously disturbed areas. 110 acres for facility; pipeline could be routed along existing rights-of-way and would require an additional 40 acres for easement.	SMALL to LARGE – Impacts are dependent on the level of renewables included in the combination alternative. Wind/solar siting and building of transmission access infrastructure could remove substantial amounts of land throughout the ROI and would remove substantially more land per MWe produced when compared to any other form of generation. Land use impacts for wind are discussed in 9.2.2.1; for solar technologies see 9.2.2.4.

Proposed Action (EGC ESP)	Coal-Fired Generation	Gas-Fired Generation	Combination	
			Gas-fired	Renewable
Water Quality Impacts				
SMALL – Construction impacts minimized by use of best management practices. Operational impacts minimized by use of best management practices by use of new cooling water system.	SMALL – Construction impacts minimized by use of best management practices. Operational impacts minimized by use of best management practices by use of new cooling water system.	SMALL – Smaller cooling water demands (then coal), inherent in combined-cycle design. Construction of pipeline could cause temporary erosion and sedimentation in streams crossed by right-of-way.	SMALL – Smaller cooling water demands (then coal), inherent in combined-cycle design. Construction of pipeline could cause temporary erosion and sedimentation in streams crossed by right-of-way.	SMALL - Some water use and quality issues will occur depending on solar technology used.
Air Quality Impacts				
SMALL – Construction impacts minimized by use of best management practices. Operational impacts are negligible.	MODERATE to LARGE – 8,127 tons SO_x/yr 2,054 tons NO_x/yr 2,118 tons CO/yr 292 tons PM/yr 67 tons PM_{10}/yr	MODERATE – 117 tons SO_x/yr 568 tons NO_x/yr 120 tons CO/yr 99 tons PM_{10}/yr[a]	SMALL to MODERATE – 117 tons SO_x/yr 568 tons NO_x/yr 120 tons CO/yr 99 tons PM_{10}/yr[a] These would be reduced based on the level of renewable generation.	SMALL - Small risk of fugitive emissions from manufacture of PV cells, or accidental leaks.

Proposed Action (EGC ESP)	Coal-Fired Generation	Gas-Fired Generation	Combination	
			Gas-fired	Renewable
Ecological Resource Impacts				
SMALL – Construction of power block would impact up to 150 acres of terrestrial habitat, potentially displacing various species. Potential new cooling towers would reduce impingement, entrainment, and thermal impacts to aquatic species.	SMALL – Construction of the power block and coal storage areas and 40 years of ash/sludge disposal would impact approximately 300 acres of terrestrial habitat, displacing various species. Potential new cooling towers would reduce impingement, entrainment, and thermal impacts to aquatic species.	SMALL – Construction of power block would impact up to 150 acres of terrestrial habitat, potentially displacing various species. Potential new cooling towers would reduce impingement, entrainment, and thermal impacts to aquatic species.	SMALL – Construction of power block would impact up to approximately 150 acres of terrestrial habitat, potentially displacing various species. Potential new cooling towers would reduce impingement, entrainment, and thermal impacts to aquatic species.	SMALL - Avian mortality remains an issue at wind farms; heavy metals (e.g., cadmium) in PV cells can lead to a variety of impacts, depending on organism and exposure.

Proposed Action (EGC ESP)	Coal-Fired Generation	Gas-Fired Generation	Combination	
			Gas-fired	Renewable
Threatened and Endangered Species				
SMALL – No resident threatened and endangered species are known to occur at the site or along transmission corridors.	SMALL – No resident threatened and endangered species are known to occur at the site or along transmission corridors.	SMALL – No resident threatened and endangered species are known to occur at the site or along transmission corridors.	SMALL – No resident threatened and endangered species are known to occur at the site.	SMALL – Siting and routing of additional transmission corridors for wind/solar installations can be altered to minimize impacts, however, altered siting may remove resources from availability.

Proposed Action (EGC ESP)	Coal-Fired Generation	Gas-Fired Generation	Combination	
			Gas-fired	Renewable
		Human Health Impacts		
SMALL – Impacts associated with noise are not anticipated. Radiological exposure is not considered significant. Risk from microbiological organisms minimal due to thermal characteristics at the discharge and lack of innoculant. Risk due to transmission-line induced currents minimal due to conformance with consensus code.	MODERATE – Adopting by reference GEIS conclusion that risks such as cancer and emphysema from emissions are likely (USNRC, 1996).	SMALL – Adopting by reference GEIS conclusion that some risk of cancer and emphysema exists from emissions (USNRC, 1996).	SMALL – Adopting by reference GEIS conclusion that some risk of cancer and emphysema exists from emissions (USNRC, 1996).	SMALL - Small carcinogen exposure risk noted from leaching materials during PV cell manufacture and at installations.

Proposed Action (EGC ESP)	Coal-Fired Generation	Gas-Fired Generation	Combination	
			Gas-fired	Renewable
Socioeconomic Impacts				
SMALL – The socioeconomic impacts for this option are discussed in Section 3.8 and Section 4.8. Public service impacts are not anticipated. Location in low population area without growth controls minimizes potential for housing impacts. Plant contribution to county tax base may be significant, and continued plant operation would benefit county. Capacity of public water supply and transportation infrastructure minimizes potential or related impacts.	SMALL – Increase in permanent work force at CPS by 250 workers could affect surrounding counties, but would be mitigated by site's proximity to metropolitan areas within the region.	SMALL – Increase in permanent work force at CPS by 25-40 workers could affect surrounding counties, but would be mitigated by the site's proximity to metropolitan areas within the region.	SMALL – Increase in permanent work force at CPS by 40-50 workers could affect surrounding counties, but would be mitigated by the site's proximity to metropolitan areas within the region.	SMALL – Potential minor impacts from reliability and transmission congestion. These transmission issues are more likely with wind. Land values may increase due to lease revenue to landowners from wind installations.

Proposed Action (EGC ESP)	Coal-Fired Generation	Gas-Fired Generation	Combination	
			Gas-fired	Renewable
Waste Management Impacts				
SMALL – Non-radiological impacts will be negligible. Radiological impacts will be small.	MODERATE – 583,865 tons of coal ash per year and 442,952 tons of scrubber sludge per year would require 234 acres over the 40-year term.	SMALL – Almost no waste generation.	SMALL – Almost no waste generation.	SMALL - Used PV cells contain potential hazardous wastes, but chemicals are sealed within the cell. Waste minimization practices also limits waste issues for used cells. Potential for leaching at landfills unknown.
Aesthetic Impacts				
SMALL – Visual impacts would be consistent with the industrial nature of the site.	SMALL – Visual impacts would be consistent with the industrial nature of the site.	SMALL – Visual impacts would be consistent with the industrial nature of the site.	SMALL – Visual impacts would be consistent with the industrial nature of the site.	SMALL to LARGE - Visual/auditory impacts of wind/solar installations could be substantial but could be mitigated through placement. Placement to mitigate this impact may remove resources from availability. The amount of the impact will depend upon the amount of resource used.

Proposed Action (EGC ESP)	Coal-Fired Generation	Gas-Fired Generation	Combination	
			Gas-fired	Renewable
Cultural Resource Impacts				
SMALL – Impacts to cultural resources would be unlikely due to developed nature of the site.	SMALL – Impacts to cultural resources would be unlikely due to developed nature of the site.	SMALL – Impacts to cultural resources would be unlikely due to developed nature of the site.	SMALL – Impacts to cultural resources would be unlikely due to developed nature of the site.	SMALL - Impacts to cultural resource of renewable portion and additional transmission infrastructure can be mitigated through placement. Placement to mitigate this impact may remove resources from availability.
Impacts of Accidents				
SMALL – Although the consequences of accidents could potentially be high, the overall risk of accidents is low given the low probability of an accident involving a significant release of radioactivity.	SMALL – Impacts of accidents in coal-fired plants are not applicable.	SMALL – Impacts of accidents in gas-fired plants are not applicable.	SMALL – Impacts of accidents in gas-fired plants and wind/solar are not applicable.	

[a] All total suspended particulates (TSP) for gas-fired alternative is PM_{10}.

Notes: SMALL – Environmental effects are not detectable or are so minor that they will neither destabilize not 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.
10 CFR 51, Subpart A, Appendix B, Table B-1, Footnote 3.

Btu = British thermal unit
MW = Megawatt
MWe = Megawatt electric
Ft^3 = cubic foot
NO_x = oxides of nitrogen
gal = gallon
PM_{10} = particulate matter having diameter less than 10 microns
GEIS = Generic Environmental Impact Statement (USNRC, 1996)
SHPO = State Historic Preservation Officer
kWh = kilowatt-hour
SO_x = sulfur oxides
lb = pound
TSP = total suspended particulates
MM = million
yr = year
PV = photovoltaic
ROI = Region of Interest

Add to Chapter 9, References for Section 9.2:

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Delete Chapter 9, References for Section 9.2:

Johnansson, T. B., et. al., eds. *Renewable Energy: Sources for Fuels and Electricity.* Island Press. Washington, D.C. 1993.

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ATTACHMENTS:

None

Enclosure 4

Wind Power

	Potential	Ability to Generate Baseload Power	Costs	Environmental Impacts
Exhibit #1[1]	N/A	N/A	N/A	N/A
Exhibit #2[2]	N/A	N/A	N/A	N/A
Exhibit #3[3]	• Exhibit projects that wind, biomass, and solar power can provide 8% of the Midwest's electricity by 2010 and 22% by 2020 **Wind Class Sites** • Most utility-scale wind plants are being installed in Class 4, 5, and 6 areas but improvements should make class 3 areas attractive in the future • The windiest areas of the Midwest are in the Great Plains—Minnesota, Iowa, Nebraska, and the Dakotas **Current and Projected Wind Performance – Class 3**[4] • 2000 – 24.5% • 2010 – 27.4% • 2020 – 29.6% **Current and Projected Wind Performance – Class 4**[5] • 2000 – 28.9% • 2010 – 32.4% • 2020 – 35.0% **Current and Projected Wind Performance – Class 5**[6] • 2000 – 33.0% • 2010 – 37.0% • 2020 – 39.9% **IL's Capacity of Grid-Connected Renewable Plants in 1999** • 0 MW	• Wind plant output is variable as wind speeds rise and fall • The intermittence of wind energy entails an added cost for the power system, which grows in proportion to wind's share of the system	**Cost of Wind Energy** • $0.03 - $0.06/kWh; the range of costs reflects the windiness of the site, the size of the plant, and the availability of tax credits and other factors **Levelized Costs – 2000 ($1999)**[7] • Class 5: $0.047/kWh • Class 4: $0.054/kWh • Class 3: $0.064/kWh **Levelized Costs – 2010 ($1999)** • Class 5: $0.037/kW • Class 4: $0.042/kWh • Class 3: $0.049/kWh **Levelized Costs – 2020 ($1999)** • Class 5: $0.028/kWh • Class 4: $0.032/kWh • Class 3: $0.037/kWh **Current and Projected Capital Costs**[8] • 2000: $1,100/kW • 2010: $810/kW • 2020: $660/kW **Current and Projected O&M Costs**[9] • 2000: $0.008/kWh • 2010: $0.005/kWh • 2020: $0.004/kWh	**Air Quality Impacts** • Wind turbines produce no air pollution, greenhouse gases, or solid wastes **Wildlife and Natural Resources Impacts** • By applying responsible siting practices, wind projects can have minimal impacts on these resources • Only one wind plant in the US, Altamont Pass in California, has reported that bird deaths have been a serious problem—no serious problems of this nature have been reported in the Midwest **Aesthetic Impacts** • Public concerns about visual and noise impacts of wind plants place limitations on where wind projects can be developed • Several positive trends in wind turbine design help mitigate these problems: as wind turbines increase in size, far fewer are needed to supply the same power; the tubular tower design of modern turbines is more pleasing to the eye than the old lattice towers; modern wind turbines are less noisy than their predecessors; with appropriate setback distances from houses and buildings, noise should not pose a serious problem

Enclosure 4

Wind Power

	Potential	Ability to Generate Baseload Power	Costs	Environmental Impacts
	Wind Turbine Availability Factor • 98% **Hydrogen Transmission** • Wind-generated electricity can be converted to hydrogen by electrolysis, and then transmitted by pipeline to urban areas, where it can be used to produce electricity in fuel cells • With substantial improvements in fuel cell technology, increases in natural gas prices, and higher than expected pricing of CO_2 emissions, transmitting wind power as hydrogen can be realized at a lower cost than transmitting wind power as electricity		**Transmission Constraints** • The report added an assumed average construction cost of $240,000 per mile to the construction cost of wind projects to address the cost of building a transmission line from a wind project to the nearest point on the transmission grid • Many of these regions in the Midwest face constraints on transmission capacity—The report assumes only a portion of the transmission grid would need upgrading at an average cost of $32,000 per mile in 2010 and by 2020 the upgrades would cost an average of $120,000 per mile **Cost of Turbines** • Today's turbines generate 750-900 kW and cost around $800 per kilowatt	**Land Use/Siting Impacts** • Given the extraordinary abundance of windy agricultural land in the Great Plains (where most Midwestern wind development has taken place), siting difficulties are unlikely to pose a major constraint until well after 2020, if at all • The same cannot be said for states in the eastern part of the Midwest, where population densities are higher and the number of suitable wind sites smaller—here, other impacts, such as noise, visual, and endangered species, come into play
Exhibit #4[10]	N/A	N/A	N/A	N/A
Exhibit #5[11]	N/A	N/A	N/A	N/A
Exhibit #6[12]	N/A	N/A	N/A	N/A
Exhibit #7[13]	N/A	N/A	N/A	N/A
Exhibit #8[14]	• According to this exhibit, wind power would account for 28% of renewable energy generation by 2010 and 39% by 2020.	N/A	N/A	N/A
Exhibit #9[15]	• According to this exhibit, wind power could produce 3% of the Midwest's electric generation by 2010 and 11.3% by 2020.	N/A	N/A	N/A
Exhibit #10[16]	N/A	N/A	N/A	N/A

Enclosure 4

Wind Power

	Potential	Ability to Generate Baseload Power	Costs	Environmental Impacts
Exhibit #11[17]	**Illinois' Class 4 Sites** • Southeast of Quincy • Bloomington Area • North of Peoria • Mattoon Area • Between Sterling & Aurora **Attributes of Illinois' Class 4 Sites** • 3,000 MW installed Wind Generation Capacity • Represents 0.4% of Illinois' land **Average Class 4 Capacity Factor** • In a Class 4 wind regime, the annual average output of a wind power plant is typically about 25% of the installed capacity **Illinois Class 3+ Sites** • Scattered throughout Illinois **Attributes of Illinois' Class 3+ Sites** • 6,000 Installed Wind Generation Capacity • Represents 0.8% of Illinois' Land	N/A	N/A	N/A

Enclosure 4

Wind Power

	Potential	Ability to Generate Baseload Power	Costs	Environmental Impacts
Exhibit #12[18]	• Exhibit predicts wind power will produce 6% of the US's electricity by 2020 • Several companies introduced turbines in the 2-MW range—larger turbines are being tested as prototypes • In 2003, Illinois saw its first installation of large-scale wind turbines • In 2003, 1,687 MW of new wind power constructed in the U.S. (a 36% increase over the installed wind power base in the U.S. at the beginning of 2003	N/A	**American Wind Energy Association Proposal to Collect Wind-Generated Electricity from Midwest and deliver it to urban centers in Midwest and West** • Add several new local transmission lines at a cost of $1 billion to facilitate 26,000 MW of new wind capacity • Construct two major high-voltage lines from the northern Plains to the East and West at a cost of $10-$20 billion to facilitate 30,000–60,000 MW of new capacity	**Land Use** • As little as 5% of land used for wind generation is required for equipment and access roads leaving the other 95% available for other uses **Bird Deaths** • If wind generated 100% of the United States' electricity today, wind would account for one of every 250 human-related bird deaths **Air Quality** • New wind capacity installed in the U.S. in 2003 displaces emissions of three million tons of carbon dioxide annually
Exhibit #13[19]	• **GE 1.5 MW Turbines** – More than 2,300 in operation today • **GE 2.X MW Turbine** – Available with capacities of 2.3, 2.5, and 2.7 MW • **GE 3.6 MW Turbine** – World's first wind turbine expressly designed for offshore use	N/A	.N/A	N/A

Enclosure 4

Wind Power

	Potential	Ability to Generate Baseload Power	Costs	Environmental Impacts
Exhibit #14[20]	**Wind Turbine Technologies** • Modern utility-scale wind turbines contain generators with rated capacity of between 600 kW and 2 MW • 3 to 5 MW turbines are being developed, and may become common in the future **U.S. Potential** • By the end of 2002, generating capacity in the U.S. was highly concentrated in just two states, California and Texas, which together accounted for about two thirds of the national total of 4,660 MW • The DOE calls for wind to meet 5% of the country's electricity by 2020	• Wind resources are intermittent. Electric utilities must match supply with demand throughout the day • In order to ensure a reliable and predictable supply of power, they contract with power generators to provide pre-determined amounts of power according to fixed schedules • Regulatory penalties for deviation from these schedules are significant • The system is predicated on the assumption that power plant operators can guarantee a certain output at some future time • This assumption is not valid for wind power plants because it is intermittent in nature	**Transmission Issues** • There are a number of factors that contribute to siting decisions. A location far removed from the power transmission grid might be uneconomic, as new transmission lines will be required to connect the wind farm to the grid. 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. Also, 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. • The cost of integrating wind power into utility grids may be excessive due to the variable nature of the wind resource. Costs, however, are low at low levels of wind penetration in the grid. The technical limits of integration are reached when wind provides about 40% or more of the total electricity on an annual basis. The economic costs of adding wind at low penetration levels are less than 0.2% cents/kWh, and at medium levels less than $0.02-0.05 cents/kWh.	**Land Use Impacts** • Wind turbines themselves occupy about 5-15% of the land area encompassed by a wind farm **Air Quality Impacts** • Lifecycle CO_2 emissions per unit of power produced by a wind farm are about 1% of that for coal plants and about 2% of that of natural gas facilities **Water Use Impact** • Wind power makes use of small amounts of water, primarily for cleaning rotor blades **Visual Impacts** • Wind turbines are located where the wind resource is best—typically in highly visible, exposed locations • Newer larger rotors rotate more slowly than their predecessors and are thus less eye-catching • To further mitigate visual impacts, wind turbines can be painted to match their surroundings

Enclosure 4

Wind Power

	Potential	Ability to Generate Baseload Power	Costs	Environmental Impacts
			Capital Costs • The installed capital cost of a wind farm is less than $1,000/kW in the U.S. ($1997) • Capital costs of wind power account for about 70% of the total cost of energy ($1997) **O&M Costs** • Maintenance costs account for about 20% of the total cost of energy – $0.005/kWh. ($1997) **Additional Costs** • Property taxes, land use, insurance, transmission/wheeling, substation maintenance, and general & administrative costs together account for 10% of the total cost of wind energy ($1997) **Tax Incentives & Subsidies** • The federal PTC is the most significant U.S. policy driving wind power production • Several states have enacted Renewable Portfolio Standards • Several states have established Public Benefit Funds whereby a small per-kWh charge is addded to residents' electricity bills to raise the needed funds. In Illinois, wind projects greater than 10 MW in size are eligible to have up to 10% of project costs paid for out of the PBF.	**Noise Impacts** • Wind energy captured by wind turbines is transformed into sound energy • Air moving by the rotors generates sound • Some sound may emanate from the gearbox and generator • The noise level of a typical wind farm at 350 meters distance varies between 35 and 45 dB(A) • Improvements in rotor technology, the many frequencies of the noise (i.e., white noise) and with proper siting considerations, wind turbines can have negligible noise impacts **Public Opposition** • Proposed wind farms sometimes encounter local opposition, especially in more densely populated areas • Research indicates that there is less opposition if communities are informed of wind power benefits **Avian Deaths** • Studies indicate that there are one or two bird deaths per turbine per year • This is a small number when contrasted with the 4-10 million birds that die each year in the U.S. from nighttime collisions with lighted telecommunications towers and the several hundred million more that die each year because of other human activities • To minimize this impact, wind farms should be carefully sited to avoid undue harm to birds

Enclosure 4

Wind Power

	Potential	Ability to Generate Baseload Power	Costs	Environmental Impacts
Exhibit #15[21]	• U.S. DOE has announced a goal of obtaining 5% of U.S. electricity from wind by 2020 • Wind energy could produce about 20% of the nation's electricity • **Capacity Factor:** 25% to 40%. Wind turbines may achieve higher capacity factors during windy periods • **Availability Factor:** 98% **States with Wind Power Development**[22] • #1 California—1,671 MW • #2 Texas—1,096 MW • Illinois is not mentioned as a state with sizable wind plants • Illinois ranks 16th in the U.S. with 61 billion kWh of energy potential/year	• Wind power is a variable, intermittent resource	**Wind Generation Cost** • **Early 1980's:** As much as $0.30/kWh • **Today:** Most plants can generate electricity for less than $0.05 in many parts of the U.S. **Transmission Issues** • The entire transmission system of the Missouri Basin needs to be extensively redesigned and redeveloped (cost of which is not provided) **Wind Power and the Utility System** • Since it is a variable resource, wind power's growing use presents problems for utility system managers • If wind generates 10–20% of electricity that a system is delivering in a given hour, it becomes an "issue" with utility system managers • If wind generates more than 20% of electricity in a given hour, the system operator begins to incur significant additional expense	**Generally** • The environmental impacts of wind power are generally local in nature **Land Use** • Each square kilometer can support about 5 MW of installed wind capacity • A utility-scale wind plant requires about 50 acres per megawatt of installed capacity • 5% (2.5 acres) or less of this area is occupied by turbines, access roads and other equipment. A wind plant located on a ridgeline in hilly terrain requires less space, as little as two acres/MW **Water Use** • Wind generation does not produce water emissions • Wind generation uses 0.001 gallons/kWh of water **Erosion** • Wind power development can cause erosion. This can be prevented through proper installation and landscaping techniques **Bird Kills** • Bird deaths from wind energy are unlikely to reach as high as 1% of those from other human-relates sources **Visual Impacts** • Using turbines of the same size and type and spacing them uniformly generally results in a wind plant that satisfies most aesthetic concerns

Enclosure 4

Wind Power

	Potential	Ability to Generate Baseload Power	Costs	Environmental Impacts
				Noise • Noise-related issues have been minimized with improved engineering and appropriate use of setbacks from nearby residences **Air Pollution** • Wind generation does not generate air or water emissions and do not produce hazardous waste
Exhibit #16[23]	N/A	N/A	• (with PTC) $0.033–$0.053/kWh[24] • (without PTC) $0.04–$0.06/kWh[25] • 20 mph winds: $0.026/kWh[26] • 18 mph winds: $0.036/kWh[27] • 16 mph winds: $0.048/kWh[28]	• Wind energy produces no emissions • Wind energy has no environmental costs resulting from mining or drilling, processing, and shipping a fuel
Exhibit #17[29]	• Installed wind generating capacity totaled 2,550 MW in 2000—less than 1% of U.S. electricity generation • Illinois ranks 16th in the U.S. with 61 billion kWh of energy potential/year	N/A	N/A	N/A
Exhibit #18[30]	N/A	N/A	N/A	N/A
Exhibit #19[31]	N/A	N/A	N/A	N/A
Exhibit #20[32]	N/A	N/A	N/A	N/A
Exhibit #21[33]	N/A	N/A	N/A	N/A
Exhibit #22[34]	N/A	N/A	N/A	N/A

Enclosure 4

Wind Power

	Potential	Ability to Generate Baseload Power	Costs	Environmental Impacts
Disclosure #1[35]	**Wind Generation in Four Cases** **(billions of kWh) 2010 2025** **Reference:** 24.07 53.16 **High:**[36] 23.43 130.1 **Low:**[37] 23.62 33.66 **DOE Goals:**[38] 30.95 331 • Despite improvements and incentives, grid-connected generators that use renewable fuels are projected to remain minor contributors to U.S. electricity supply. • Non-hydroelectric renewables account for 6.6% of projected additions to U.S. generating capacity from 2002 to 2025 • From 4.8 gigawatts in 2002, total wind capacity is projected to increase to 8.0 gigawatts in 2010 and 16.0 gigawatts in 2025 • Generation from wind capacity is projected to increase from about 11 billion kWh in 2002 (0.3%) generation to 53 billion in 2025 (0.9%). • The mid-term prospects for wind power are uncertain, depending on future cost and performance, transmission availability, extension of the FPTC after [2005], other incentives, energy security, public interest, and environmental preferences • 1.9 gigawatts of new wind power capacity is projected as a result of State mandates	N/A	N/A	N/A

Enclosure 4

Wind Power

	Potential	Ability to Generate Baseload Power	Costs	Environmental Impacts
Disclosure #2[39]	• Approximately $1.5 billion in new investment in wind power in Illinois (1,700 MW in ten counties)	N/A	N/A	N/A
Disclosure #3[40]	• In 2000, renewable energies accounted for only 0.3% of Illinois' electricity generation • Only 2% of the U.S. energy comes from renewable resources • Illinois ranks 14th nationally for renewable energy potential • Illinois could generate 106 billion kWh from wind alone, more than the electricity it currently generates from coal, oil, and gas combined • Currently, Illinois has several wind projects in operation or in development stages	N/A	• The cost of electricity from utility-scale wind systems has dropped by more than 80% over the last 20 years	N/A

Enclosure 4

Wind Power

	Potential	Ability to Generate Baseload Power	Costs	Environmental Impacts
Disclosure #4[41]	• Wind power accounted for about 1/10 of 1% of total U.S. electric power generation capacity in 2003 • Theoretically, the U.S. Midwest has enough power potential to meet a significant portion of the nation's electricity needs but this potential remains untapped because many of the states with the greatest wind potential have seen little investment, these windy areas are not near significant population centers, and there is a lack of adequate transmission capacity • As of 12/03, IL has 50.4 MW of installed wind power generating capacity • Illinois ranks 16th nationally in both installed wind power generating capacity and wind resource potential • Only a small area in East Central Illinois is identified as having "moderate" wind potential—Illinois has no areas designated as "good" or "excellent" •	• Wind power is an intermittent source in that wind speed and availability can vary from day to day, and thus the amount of electricity produced varies • Wind power turbines operate the equivalent of less than 40% of the peak hours in a year • Wind power's unique characteristics can constrain its use in an existing transmission system that was built to accommodate large central-station power plants located near population centers	**Generally** • The cost of electricity from utility-scale wind power projects was as high as $0.30 per kWh in the 1980's • Currently, the DOE estimates that the cost of generating electricity from wind power is $0.03– $0.06 • If natural gas prices continue to rise, wind power is likely to be competitive in parts of the country with wind resources and transmission access • Wind power will continue to be too expensive to compete with fossil-fuel generation in parts of the country with poor wind resources • Direct Public Sector Support Programs have been instrumental to increasing the demand for wind power because of its competitive disadvantages in most domestic markets	**Air Quality** • Wind power does not create pollution or greenhouse gas emissions **Avian Concerns** • If wind farm locations are commonly used by endangered or threatened avian species or are in bird migration pathways, they may be unsuitable for wind power development **Siting Issues** • Developers must avoid placing wind turbines in scenic areas that may have high wind potential, such as ridge lines, mountain overpasses, or off-shore coastal areas, or else risk expensive litigation with local communities • There is also a great deal of concern with respect to the noise emitted by wind turbines

Enclosure 4

Wind Power

	Potential	Ability to Generate Baseload Power	Costs	Environmental Impacts
			Transmission Issues • Frequent, strong winds are found in sparsely populated areas, which may be far from transmission lines with adequate capacity to bring power to consumers • A renewable energy generator incurs transmission pricing mechanisms that charge according to the distance covered or according to the number of utility territories crossed • Also, transmission capacity is limited in many areas of the nation for all electric power sources • Developing new renewable facilities requires up-front costs to build the necessary infrastructure. The average cost of building new power lines to connect turbines to the transmission grid cost $100,000 or more per mile **Economies of Scale** • The current demand for wind technologies is not enough to achieve the economies of scale through mass production	
Disclosure #5[42]	N/A	N/A	• Wind power's levelized cost of electricity ranges from $55–$77/MWh	N/A

Enclosure 4

Wind Power

	Potential	Ability to Generate Baseload Power	Costs	Environmental Impacts
Disclosure #6[43]	• Map and chart show 1,439 MW of operating and 11,759 MW of proposed wind power projects in the Midwest. • Illinois—50 MW of operating and 3,119 MW of proposed wind power projects • North Dakota—81 MW of operating and 579 MW of proposed wind power projects • South Dakota—41 MW of operating and 509 MW of proposed wind power projects • Nebraska—11 MW of operating and 2,324 MW of proposed wind power projects • Minnesota—558 MW of operating and 2,211 MW of proposed wind power projects • Iowa—536 MW of operating and 610 of proposed wind power projects • Missouri—0 MW of operating and 200 MW of proposed wind power projects • Wisconsin—50 MW of operating and 1,657 MW of proposed wind power projects • Michigan—0 MW of operating and 140 MW of proposed wind power projects • Indiana—0 MW of operating and 350 MW of proposed wind power projects		•	

Enclosure 4

Wind Power

	Potential	Ability to Generate Baseload Power	Costs	Environmental Impacts
Disclosure #7[44]	• In Germany there is 13,500 MW of installed wind capacity, of which 3,200 MW was installed in 2002 • France has 220 MW of installed wind capacity • European Wind Energy Association cautiously estimates that the installed wind capacity by 2010 will be 75,000 MW • The study indicates that at equal investment with nuclear power, wind power generates 5 times more jobs and 2.3 more electricity than nuclear	N/A	N/A	N/A

[1] U.S. Nuclear Regulatory Commission, Public Scoping Meeting Transcript (Dec. 18, 2003).

[2] U.S. Nuclear Regulatory Commission, Public Scoping Meeting PowerPoint Slides and Handout (Dec. 18, 2003).

[3] Environmental Law and Policy Center, et al., *Repowering the Midwest: The Clean Energy Development Plan for the Heartland* (2001).

[4] Assumes an average new wind plant size of 50 MW in 2000 and 100 MW in 2010 and 2020. The capacity factor increases reflect projected improvements in technology and increases in tower height from 60 to 80 meters in 2010 and 100 meters in 2020. The capacity factors include expected electrical, mechanical, and wake losses.

[5] *Id.*

[6] *Id.*

[7] Assumes a production tax credit in 2000 with a levelized value of $0.01/kWh. This is not included in the 2010 and 2020 estimates.

[8] Assumes an average new wind plant size of 50 MW in 2000 and 100 MW in 2010 and 2020. Capital costs do not include transmission interconnection.

[9] Assumes an average new wind plant size of 50 MW in 2000 and 100 MW in 2010 and 2020.

[10] U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, *Scenarios of U.S. Carbon Reductions—Potential Impacts of Energy Technologies by 2010 and Beyond* (1997) (The Executive Summary of this Document was attached as Exhibit 4).

[11] Interlaboratory Working Group, *Scenarios for a Clean Energy Future* (2000).

[12] Steve Nadel and Howard Geller, *Smart Energy Policies: Saving Money and Reducing Pollutant Emissions through Greater Energy Efficiency* (2001).

[13] Toru Kubo, Harvey Sachs, & Steven Nadel, *Opportunities for New Appliance and Equipment Efficiency Standards: Energy and Economic Savings Beyond Current Standards Programs* (2001).

[14] Steve Clemmer, Deborah Donovan, Alan Nogee, & Jeff Deyette, *Clean Energy Blueprint—A Smarter National Energy Policy for Today and the Future* (2001).

[15] Environmental Law and Policy Center, et al., *Job Jolt—The Economic Impacts of Repowering the Midwest: The Clean Energy Development Plan for the Heartland* (2002).

[16] Marshall Goldberg, et al., *Energy Efficiency and Economic Development in Illinois* (1998).

[17] U.S. Department of Energy, *Wind Powering America—Illinois Resource Maps* (exhibit indicates that Intervenors last visited web site May, 2004) *at* http://www.eere.energy.gov/windpoweringamerica/where_is_wind_illinois.html.

[18] American Wind Energy Association, *Wind Power Outlook 2004* (2004).

[19] GE Wind Energy, *Our Products* (exhibit indicates that Intervenors last visited web site Apr. 2004) *at* http://www.gepower.com/businesses/ge_wind_energy/en/products.htm.

[20] Ari Reeves, *Wind Energy for Electric Power—A REPP Issue Brief* (2003).

[21] American Wind Energy Association, *The Most Frequently Asked Questions about Wind Energy*, (2002).

[22] As of the end of 2001.

[23] American Wind Energy Association, *Wind Energy Fact Sheet—Comparative Cost of Wind and Other Energy Sources* (2002).

[24] As of the year 1996.

[25] *Id.*

[26] No year indicated.

[27] *Id.*

[28] *Id.*

[29] American Wind Energy Association, *Wind Energy Fact Sheet—Wind Energy: An Untapped Resource* (2003).

[30] Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada (Feb. 2002), at A-1.

[31] United States Nuclear Waste Technical Review Board, *A Report to Congress and the Secretary of Energy—Disposal and Storage of Spent Nuclear Fuel: Finding the Right Balance* (Mar. 1996), Figure 2 at page 11. (Mar. 1996).

[32] Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada (Feb. 2002), Table A-8, at A-16.

[33] United States General Accounting Office, *Nuclear Waste—Technical, Schedule and Cost Uncertainties of the Yucca Mountain Repository Project* (Dec. 2001) (GAO-02-191).

[34] Letter from the United States Nuclear Waste Technical Review Board, to Dr. Margaret S. Y. Chu, Director, Office of Civilian Radioactive Waste Management (Nov. 25, 2003).

[35] United States Department of Energy, Energy Information Administration, *Annual Energy Outlook 2004 with Projections to 2025* (2004), *at* http://www.eia.doe.gov/oiaf/aeo/electricity.html.

[36] In the high renewables case, additions of wind capacity are substantially higher than projected in the reference case, with most of the incremental capacity added between 2010 and 2025. The high renewables case assumes cost reduction of 10% on a site-specific basis.

[37] In the low renewables case, construction of new renewable capacity is considerably lower than projected in the reference case. The low renewables case assumes that the cost and performance characteristics for key non-hydropower renewable energy technologies remain fixed at current levels.

[38] In the DOE goals case, still more wind is projected to be added. Generation from wind power in 2010 is 29% higher in the DOE goals case, at 31 billion kWh, than in the reference case, and in 2025 it is more than six times higher, at 331 billion kWh or 5.7% of total generation. The DOE goals case assumes lower capital costs, higher capacity factors, and lower operating costs, based on the renewable energy goals of the DOE.

[39] Environmental Law & Policy Center, *Wind Projects Under Development in Illinois* (year of publication not indicated).

[40] Alison Cassady & Katherine Morrison, *Generating Solutions: How Clean, Renewable Energy is Boosting Local Economies and Saving Consumers Money* (2003). In estimating Illinois' renewable energy potential, this study included class 3 and higher wind land area within 20 miles of existing transmission lines, excluding all urban and environmentally sensitive areas, 50% of forest land, 30% of agricultural land, and 10% of range land.

[41] United States Government Accountability Office, *Renewable Energy—Wind Power's Contribution to Electric Power Generation and Impact on Farms and Rural Communities* (2004) (GAO-04-756).

[42] University of Chicago, *The Future of Nuclear Power* (2004).

[43] Environmental Law & Policy Center, *Wind Power Projects* (2005).

[44] Greenpeace France, *Wind v. Nuclear 2003* (2003).

Enclosure 5

Solar Power

	Potential	Ability to Generate Baseload Power	Costs	Environmental Impacts
Exhibit #1[1]	N/A	N/A	N/A	N/A
Exhibit #2[2]	N/A	N/A	N/A	N/A
Exhibit #3[3]	• Exhibit projects that wind, biomass, and solar power can provide 8% of the Midwest's electricity by 2010 and 22% by 2020. • Chicago, IL is supporting Spire Solar's new solar panel manufacturing plant, installing solar panels on the rooftops of nine major museums, and planning to build the largest single PV assembly (2.5 MW) in the country	N/A	**Capital Costs of Grid-Connected Fixed Flat-Plate PV System**[4] • 2000 - $5,416/kW • 2010 - $2,877/kW • 2020 - $2,275/kW **O&M Costs of Grid-Connected Fixed Flat-Plate PV Systems**[5] • 2000 - $56/kW-yr • 2010 - $23/kW-yr • 2020 - $17/kW-yr **Cost of Large Grid-Connected PV Systems** • Small Systems cost between $9,000/kW and $11,000/kW • Intermediate systems cost between $5,000/kW to $8,000/kW • Large systems are estimated to cost between $5,000/kW and $6,000/kW **Levelized Cost of Solar PV (CF 18%) ($1999)** • 2000 - $0.48/kWh • 2010 - $0.25/kWh • 2020 - $0.20/kWh **Levelized Cost of Solar PV (CF 23%) ($1999)** • 2000 - $0.37/kWh • 2010 - $0.20/kWh • 2020 - $0.15/kWh	• Solar power creates no air pollution, greenhouse gases, or radioactive and other wastes
Exhibit #4[6]	N/A	N/A	N/A	N/A
Exhibit #5[7]	N/A	N/A	N/A	N/A
Exhibit #6[8]	N/A	N/A	N/A	N/A
Exhibit #7[9]	N/A	N/A	N/A	N/A

Enclosure 5

Solar Power

	Potential	Ability to Generate Baseload Power	Costs	Environmental Impacts
Exhibit #8[10]	N/A	N/A	N/A	N/A
Exhibit #9[11]	N/A	N/A	N/A	N/A
Exhibit #10[12]	N/A	N/A	N/A	N/A
Exhibit #11[13]	N/A	N/A	N/A	N/A
Exhibit #12[14]	N/A	N/A	N/A	N/A
Exhibit #13[15]	N/A	N/A	N/A	N/A
Exhibit #14[16]	N/A	N/A	N/A	N/A
Exhibit #15[17]	N/A	N/A	N/A	N/A
Exhibit #16[18]	N/A	N/A	N/A	N/A
Exhibit #17[19]	N/A	N/A	N/A	N/A
Exhibit #18[20]	N/A	N/A	N/A	N/A
Exhibit #19[21]	N/A	N/A	N/A	N/A
Exhibit #20[22]	N/A	N/A	N/A	N/A
Exhibit #21[23]	N/A	N/A	N/A	N/A
Exhibit #22[24]	N/A	N/A	N/A	N/A
Disclosure #1[25]	• Non-hydroelectric renewables account for 6.6% of projected additions to U.S. generating capacity from 2002 to 2025 and 6.8% of the projected increase in generation • In total, grid-connected PV and solar thermal generators together provided about 0.02% of total generation and are projected to supply 0.08% in 2025 • 0.1 gigawatts of new PV and thermal is projected as a result of State mandates	N/A	N/A	N/A
Disclosure #2[26]	N/A	N/A	N/A	N/A

Enclosure 5

Solar Power

	Potential	Ability to Generate Baseload Power	Costs	Environmental Impacts
Disclosure #3[27]	• In 2000, renewable energies accounted for only 0.3% of Illinois' electricity generation • Only 2% of the U.S. energy comes from renewable resources • Illinois has useful solar resources throughout most of the state • If IL installed a PV array with a collector area equal to the size of a football field, the state could produce around 927,000 kWh per year – enough to power 93 homes • If IL installed one concentrating solar system covering approximately 200 acres, it could produce 32,624,000 kWh/year – enough to power 3,274 homes •	• The availability of light varies greatly depending on the location—during periods for which there is insufficient light to produce the power demanded, solar power systems require a supplemental power supply, such as direct connection to an electricity grid, batteries, fuel cells, or a small generator	• The cost of electricity of solar energy has dropped by nearly 80% over the last 20 years	N/A
Disclosure #4[28]	N/A	N/A	N/A	N/A
Disclosure #5[29]	N/A	N/A	• Solar Thermal's levelized cost of electricity ranges from $158–$235/MWh. • Solar PV's levelized cost of electricity ranges from $ 202–$308/MWh	N/A
Disclosure #6[30]	N/A	N/A	N/A	N/A
Disclosure #7[31]	N/A	N/A	N/A	N/A

[1] U.S. Nuclear Regulatory Commission, Public Scoping Meeting Transcript (Dec. 18, 2003).

[2] U.S. Nuclear Regulatory Commission, Public Scoping Meeting PowerPoint Slides and Handout (Dec. 18, 2003).

[3] Environmental Law and Policy Center, et al., *Repowering the Midwest: The Clean Energy Development Plan for the Heartland* (2001).

[4] Report assumes the grid-connected system will be of intermediate size. A technological optimism factor of 1.12 was applied to the estimated current overnight capacity cost. Then, cost reductions of 20% were assumed for each of the first three doublings of global PV capacity over today's capacity, 5% for the next five doublings, and 1% for all doublings thereafter. Lastly, the analysis assumes that the global installed PV capacity will grow at an average annual rate of 17.5% over the next twenty years.

[5] Exhibit assumes the grid connected system will be of intermediate size.

[6] U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, *Scenarios of U.S. Carbon Reductions—Potential Impacts of Energy Technologies by 2010 and Beyond* (1997) (The Executive Summary of this Document was attached as Exhibit 4).

[7] Interlaboratory Working Group, *Scenarios for a Clean Energy Future* (2000).

[8] Steve Nadel and Howard Geller, *Smart Energy Policies: Saving Money and Reducing Pollutant Emissions through Greater Energy Efficiency* (2001).

[9] Toru Kubo, Harvey Sachs, & Steven Nadel, *Opportunities for New Appliance and Equipment Efficiency Standards: Energy and Economic Savings Beyond Current Standards Programs* (2001).

[10] Steve Clemmer, Deborah Donovan, Alan Nogee, & Jeff Deyette, *Clean Energy Blueprint—A Smarter National Energy Policy for Today and the Future* (2001).

[11] Environmental Law and Policy Center, et al., *Job Jolt—The Economic Impacts of Repowering the Midwest: The Clean Energy Development Plan for the Heartland* (2002).

[12] Marshall Goldberg, et al., *Energy Efficiency and Economic Development in Illinois* (1998).

[13] U.S. Department of Energy, *Wind Powering America—Illinois Resource Maps* (exhibit indicates that Intervenors last visited web site May, 2004) *at* http://www.eere.energy.gov/windpoweringamerica/where_is_wind_illinois.html.

[14] American Wind Energy Association, *Wind Power Outlook 2004* (2004).

[15] GE Wind Energy, *Our Products* (exhibit indicates that Intervenors last visited web site Apr. 2004) *at* http://www.gepower.com/businesses/ge_wind_energy/en/products.htm.

[16] Ari Reeves, *Wind Energy for Electric Power—A REPP Issue Brief* (2003).

[17] American Wind Energy Association, *The Most Frequently Asked Questions about Wind Energy*, (2002).

[18] American Wind Energy Association, *Wind Energy Fact Sheet—Comparative Cost of Wind and Other Energy Sources* (2002).

[19] American Wind Energy Association, *Wind Energy Fact Sheet—Wind Energy: An Untapped Resource* (2003).

[20] Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada (Feb. 2002), at A-1.

[21] United States Nuclear Waste Technical Review Board, *A Report to Congress and the Secretary of Energy—Disposal and Storage of Spent Nuclear Fuel: Finding the Right Balance* (Mar. 1996), Figure 2 at page 11. (Mar. 1996).

[22] Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada (Feb. 2002), Table A-8, at A-16.

[23] United States General Accounting Office, *Nuclear Waste—Technical, Schedule and Cost Uncertainties of the Yucca Mountain Repository Project* (Dec. 2001) (GAO-02-191).

[24] Letter from the United States Nuclear Waste Technical Review Board, to Dr. Margaret S. Y. Chu, Director, Office of Civilian Radioactive Waste Management (Nov. 25, 2003).

[25] United States Department of Energy, Energy Information Administration, *Annual Energy Outlook 2004 with Projections to 2025* (2004), *at* http://www.eia.doe.gov/oiaf/aeo/electricity.html.

[26] Environmental Law & Policy Center, *Wind Projects Under Development in Illinois* (year of publication not indicated).

[27] Alison Cassady & Katherine Morrison, *Generating Solutions: How Clean, Renewable Energy is Boosting Local Economies and Saving Consumers Money* (2003). Solar energy was not included in this study's calculation of each state's renewable energy potential, as the technical potential for solar is limited only by space and cost. In order to quantify each state's solar potential, assumptions about cost and rooftop and other space available now and in the future for PV would have to be made.

[28] United States Government Accountability Office, *Renewable Energy—Wind Power's Contribution to Electric Power Generation and Impact on Farms and Rural Communities* (2004) (GAO-04-756).

[29] University of Chicago, *The Future of Nuclear Power* (2004).

[30] Environmental Law & Policy Center, *Wind Power Projects* (2005).

[31] Greenpeace France, *Wind v. Nuclear 2003* (2003).

Enclosure 6

Wind and/or Solar in Combination with Natural Gas and/or Coal Generation

	Potential	Ability to Generate Baseload Power	Costs	Environmental Impacts
Exhibit #1[1]	N/A	N/A	N/A	N/A
Exhibit #2[2]	N/A	N/A	N/A	N/A
Exhibit #3[3]	N/A	• Wind and solar technologies are unavoidably intermittent and will need to be supplemented with less intermittent energy supplies • Currently, that means conventional electricity plants but in the future the electricity supply could be regulated through the use of baseload biomass gasifiers, hydrogen fuel cells, hydrogen pipelines, and other storage technologies	•	
Exhibit #4[4]	N/A	N/A	N/A	N/A
Exhibit #5[5]	N/A	N/A	N/A	N/A
Exhibit #6[6]	N/A	N/A	N/A	N/A
Exhibit #7[7]	N/A	N/A	N/A	N/A
Exhibit #8[8]	N/A	N/A	N/A	N/A
Exhibit #9[9]	N/A	N/A	N/A	N/A
Exhibit #10[10]	N/A	N/A	N/A	N/A
Exhibit #11[11]	N/A	N/A	N/A	N/A
Exhibit #12[12]	N/A	N/A	**Wind/Natural Gas Compatibility** **Costs** / **Wind** / **Natural Gas** Operating: Low / High Capital: High / Low Fuel Supply: No / Yes	**Wind/Natural Gas Compatibility** • Wind produces no emissions, while natural gas produces smog, and greenhouse gases
Exhibit #13[13]	N/A	N/A	N/A	N/A
Exhibit #14[14]	N/A	N/A	N/A	N/A
Exhibit #15[15]	N/A	N/A	N/A	N/A
Exhibit #16[16]	N/A	N/A	N/A	N/A
Exhibit #17[17]	N/A	N/A	N/A	N/A
Exhibit #18[18]	N/A	N/A	N/A	N/A

Enclosure 6

Wind and/or Solar in Combination with Natural Gas and/or Coal Generation

	Potential	Ability to Generate Baseload Power	Costs	Environmental Impacts
Exhibit #19[19]	N/A	N/A	N/A	N/A
Exhibit #20[20]	N/A	N/A	N/A	N/A
Exhibit #21[21]	N/A	N/A	N/A	N/A
Exhibit #22[22]	N/A	N/A	N/A	N/A
Disclosure #1[23]	N/A	N/A	N/A	N/A
Disclosure #2[24]	N/A	N/A	N/A	N/A
Disclosure #3[25]	N/A	N/A	N/A	N/A
Disclosure #4[26]	N/A	N/A	N/A	N/A
Disclosure #5[27]	N/A	N/A	**Pulverized Coal Combustion** **Capital Cost ($/kW):** 1,189.00 **Fuel Cost:** 11.26 **O&M Costs ($/MWh):** 7.73 **Construction Time (years):** 4 ***Coal – Circulating Fluidized Bed*** **Capital Cost ($/kW):** 1,200.00 **Fuel Cost:** 12.04 **O&M Costs ($/MWh):** 5.87 **Construction Time (years):** 4 **Coal – Integrated Gasification Combined Cycle** **Capital Cost ($/kW):** 1,338.00 **Fuel Cost:** 9.44 **O&M Costs ($/MWh):** 5.19 **Construction Time (years):** 4 **Gas Turbine Combined Cycle** **Capital Cost ($/kW):** 590.00 **Fuel Cost:** 23.60 **O&M Costs ($/MWh):** 2.60 **Construction Time (years):** 3	N/A

Enclosure 6

Wind and/or Solar in Combination with Natural Gas and/or Coal Generation

	Potential	Ability to Generate Baseload Power	Costs	Environmental Impacts
			Fuel Prices • **Coal** – Supplies worldwide are expected to be sufficiently price elastic that even doubling of demand would not increase price appreciably—previous forecasts generally agree that coal production will increase 35–50% over the next 25 years. Forecasts for the U.S. coal price to utilities uniformly predict a decline of about 10% • **Natural Gas** – Forecasts are mixed—EIA's forecasts have changed sharply as prices experienced during the 2000-03 have fluctuated considerably. Expressed in 2003 prices, the Lower 48 wellhead price rose form \$3.93 per 1000 cu. ft. in 2000 to \$4.24 in 2001, then fell to \$3.02 in 2002. The 2003 price was \$5.01. EIA's forecast for 2020, in 2003 prices, was \$3.75 but its 2004 for 2020 for the same data is now \$4.34.	
Disclosure #6[28]	N/A	N/A	N/A	N/A
Disclosure #7[29]	N/A	N/A	N/A	N/A

[1] U.S. Nuclear Regulatory Commission Public Scoping Meeting Transcript (Dec. 18, 2003).

[2] U.S. Nuclear Regulatory Commission, Public Scoping Meeting PowerPoint Slides and Handout (Dec. 18. 2003)

[3] Environmental Law and Policy Center, et al., *Repowering the Midwest: The Clean Energy Development Plan for the Heartland* (2001)

[4] U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, *Scenarios of U.S. Carbon Reductions – Potential Impacts of Energy Technologies by 2010 and beyond* (1997). (The Executive Summary of this Document was attached as Exhibit 4)

[5] Interlaboratory Working Group, *Scenarios for a Clean Energy Future* (2000)

[6] Steve Nadel and Howard Geller, *Smart Energy Policies: Saving Money and Reducing Pollutant Emissions through Greater Energy Efficiency* (2001)

[7] Toru Kubo, Harvey Sachs, & Steven Nadel, *Opportunities for New Appliance and Equipment Efficiency Standards: Energy and Economic Savings Beyond Current Standards Programs* (2001)

[8] Steve Clemmer, Deborah Donovan, Alan Nogee, & Jeff Deyette, *Clean Energy Blueprint—A Smarter National Energy Policy for Today and the Future* (2001)

[9] Environmental Law and Policy Center, et al., *Job Jolt—The Economic Impacts of Repowering the Midwest: The Clean Energy Development Plan for the Heartland* (2002).

[10] Marshall Goldberg, et al., *Energy Efficiency and Economic Development in Illinois* (1998).

[11] U.S. Department of Energy, *Wind Powering America—Illinois Resource Maps* (exhibit indicates that Intervenors last visited web site May, 2004) *at* http://www.eere.energy.gov/windpoweringamerica/where_is_wind_illinois.html.

[12] American Wind Energy Association, *Wind Power Outlook 2004* (2004).

[13] GE Wind Energy, *Our Products* (exhibit indicates that Intervenors last visited web site Apr. 2004) *at* http://www.gepower.com/businesses/ge_wind_energy/en/products.htm.

[14] Ari Reeves, *Wind Energy for Electric Power—A REPP Issue Brief* (2003).

[15] American Wind Energy Association, *The Most Frequently Asked Questions about Wind Energy*, (2002).

[16] American Wind Energy Association, *Wind Energy Fact Sheet—Comparative Cost of Wind and Other Energy Sources* (2002).

[17] American Wind Energy Association, *Wind Energy Fact Sheet—Wind Energy: An Untapped Resource* (2003).

[18] Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada (Feb. 2002), at A-1.

[19] United States Nuclear Waste Technical Review Board, *A Report to Congress and the Secretary of Energy—Disposal and Storage of Spent Nuclear Fuel: Finding the Right Balance* (Mar. 1996), Figure 2 at page 11. (Mar. 1996).

[20] Final Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada (Feb. 2002), Table A-8, at A-16.

[21] United States General Accounting Office, *Nuclear Waste—Technical, Schedule and Cost Uncertainties of the Yucca Mountain Repository Project* (Dec. 2001) (GAO-02-191).

[22] Letter the from United States Nuclear Waste Technical Review Board, to Dr. Margaret S. Y. Chu, Director, Office of Civilian Radioactive Waste Management (Nov. 25, 2003).

[23] United States Department of Energy, Energy Information Administration, *Annual Energy Outlook 2004 with Projections to 2025* (2004), *at* http://www.eia.doe.gov/oiaf/aeo/electricity.html.

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[25] Alison Cassady & Katherine Morrison, *Generating Solutions: How Clean, Renewable Energy is Boosting Local Economies and Saving Consumers Money* (2003).

[26] United States Government Accountability Office, *Renewable Energy—Wind Power's Contribution to Electric Power Generation and Impact on Farms and Rural Communities* (2004) (GAO-04-756).

[27] University of Chicago, *The Future of Nuclear Power* (2004).

[28] Environmental Law & Policy Center, *Wind Power Projects* (2005).

[29] Greenpeace France, *Wind v. Nuclear 2003*, (2003).

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

Before the Commission

In the Matter of	)	**Docket No. 52-007-ESP**
EXELON GENERATION COMPANY, LLC	)	**ASLBP No. 04-821-01-ESP**
(Early Site Permit for the Clinton ESP Site)	)	**March 17, 2005**

NOTICE OF APPEARANCE OF ANNETTE M. SIMON

The undersigned, being an attorney at law in good standing admitted to practice before the courts of South Dakota, hereby enters her appearance in the above-captioned matter as counsel on behalf of Applicant, Exelon Generation Company, LLC, 200 Exelon Way, KSA3-E, Kennett Square, PA, 19348.

Name: Annette M. Simon
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Dated: March 17, 2005

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	Docket No. 52-007
EXELON GENERATION COMPANY, LLC	)	ASLBP No. 04-821-01-ESP
(Early Site Permit for the Clinton ESP Site)	)	

CERTIFICATE OF SERVICE

I hereby certify that copies of Exelon's Motion for Summary Disposition of Contention 3.1, together with the Statement of Material Facts On Which No Genuine Issue Exists and the Joint Affidavit of William D. Maher and Curtis L. Bagnall, and a Notice of Appearance for Annette M. Simon in the captioned proceeding have been served as shown below by deposit in the United States mail, first class, this 17th day of March 2005. Additional service has also been made this same day by electronic mail as shown below.

Office of the Secretary* U.S. Nuclear Regulatory Commission Attn: Rulemakings and Adjudication Staff Washington, DC 20555-0001 email: hearingdocket@nrc.gov	Office of Commission Appellate Adjudication U.S. Nuclear Regulatory Commission Washington, DC 20555-0001
Diane Curan, Esq. Harmon, Curran, Spielberg & Eisenberg, L.L.P. 1726 M Street, N.W., Suite 600 Washington, DC 20036 email: dcurran@harmoncurran.com	Dave Kraft, Executive Director Nuclear Energy Information Service P.O. Box 1637 Evanston, IL 60204-1637 email: neis@neis.org
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* Original and two copies