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September 24, 2004

Dr. Paul B. Abramson
Dr. Anthony J. Baratta
Dr. David L. Hetrick
Atomic Safety and Licensing Board Panel
U.S. Nuclear Regulatory Commission
Washington, DC 20555-0001

Docket: *Exelon Generating Company, LLC* (Early Site Permit for the Clinton ESP Site), Docket No. 52-007

Re: Response to NRC Request for Additional Information (RAI) Related to Contention 3.1

Dear Licensing Board Members:

The purpose of this letter is to provide the Licensing Board and the parties with a copy of a letter dated September 23, 2004 from Exelon Generating Company (EGC) to the NRC staff. EGC's letter responds to several RAIs from the NRC staff, including an RAI related to Contention 3.1.

Pursuant to 10 CFR § 2.336(d), we are collecting the documents that were obtained and developed in preparing this response, and we will be will be updating our discovery disclosures within the next two weeks to account for these additional documents.

Respectfully submitted,

Steven P. Frantz
Counsel for Exelon Generation Company, LLC

cc: Service List

Template=SECY-043

SECY-02

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 letter dated September 24, 2004 from Steven P. Frantz to the Atomic Safety and Licensing Board members in the captioned proceeding have been served as shown below by deposit in the United States mail, first class, this 24th day of September 2004. 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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Nuclear

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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

Responses to Environmental RAIs

Response to the following environmental RAIs is provided in this enclosure:

E3.8-4

E7.2-3 (f)

NRC RAI No. E3.8-4

The following are specific questions related to Section 3.8 of the ER:

E3.8-4 General – Provide a transportation risk assessment for gas-cooled reactor spent fuel shipments using an accepted methodology, such as RADTRAN V. Provide justification that the best available information has been used to generate the RADTRAN input values, and that those values are appropriate for gas-cooled fuel shipments. Provide a comparison of the results of that assessment with the spent fuel shipment risk estimates contained in NUREG-0170, *Final Environmental Statement on the Transportation of Radioactive Material by Air and Other Modes.*

EGC RAI ID: R3-8

REVISED EGC RESPONSE:
RADTRAN V highway runs were conducted for a GT-MHR and a PBMR spent fuel shipment from Maine Yankee Nuclear Plant to Yucca Mountain. The TRAGIS Routing Engine Version 1.4.15, which uses the 2000 Census data, provided the routing information and the population densities. The analysis was conservative using the 10 CFR 71 regulatory limits of 2 mrem/hr in the cab and 10 mrem/hr at 2 meters from the cask. The input values were taken primarily from the Yucca Mountain Final EIS in particular the *Transportation Health and Safety Calculation/Analysis Documentation in Support of the Final EIS for the Yucca Mountain Repository.* Specifically, the values for the high integrity high-temperature gas-cooled reactor SNF referred to a type 8 were used. A comparison of the incident free results with NUREG-0170 is provided in the Table below.

	NUREG-0170 [1] (person-rem/ shipment)	GTMHR RADTRAN V Results[2] (person-rem/ shipment)	PBMR RADTRAN V Results[3] (person-rem /shipment)	Difference between RADTRAN V results and NUREG-0170
Passengers	0	0.000	0.000	0.000
Crew	0.123	0.157	0.157	0.034
Attendants	0.000	0.000	0.000	0.000
Handlers	0.200	0.188	0.188	-0.012
Off-Link	0.015	0.012	0.012	-0.003
On-Link	0.007	0.081	0.081	0.073
Stops	0.019	0.190	0.190	0.171
Storage	0.005	0.000	0.000	-0.005
Totals	0.369	0.628	0.628	0.259

1. Based on 1530 spent fuel truck shipments for the year 1985
2. GT-MHR Spent Fuel from Maine Yankee to Yucca Mountain
3. PBMR Spent Fuel from Maine Yankee to Yucca Mountain

The major difference is the dose during stops. Much of this difference is attributable to the RADTRAN V simulations included inspections at the beginning and the end of the trip. NUREG-0170 did not include these inspections. The remaining difference can be attributed to greater distance traveled, hence more refueling stops, and the different methodologies used to calculate the stop doses. This evaluation used 1996 truck stop data (*Investigation of Radtran Stop Model Input Parameters for Truck Stops,* SAND96-0714C) and modeled public doses in two concentric rings: 1 m to 14 m and 30m to 800m. The population in the inner ring used the results of the Stop Model study while the population in the outer ring used route specific 2000 Census population data weighted by a 3% urban, 26% suburban and 71% rural distribution. The NUREG-0170 study modeled just one ring, 10 to 2600 feet, and used three fixed population densities.

Factors contributing to the increased on-link population dose are NUREG-0170 assumed a 2500 km shipment distance with a 5% urban, 5% suburban and 90% rural population. This evaluation used updated 2000 census information showing a 3% urban, 26% suburban and 71% rural population and a 4,733 km shipment distance.

In addition to the incident free results, the RADTRAN V runs also included accident results. Due to the preliminary nature of the gas-cooled reactor fuel designs, it is premature to provide a meaningful comparison with NUREG-0170. The RADTRAN V runs were made with the gas-cooled fuel values provided in the Yucca Mountain FEIS. Specifically, the values for the high integrity high-temperature gas-cooled reactor spent nuclear fuel referred to as type 8 were used. As such, these runs provide a reasonable estimate of what the GT-MHR and PBMR results might look like. It is important to remember that the gas-cooled reactor spent fuel shipments are no different from any other spent fuel shipments in that all shipments are required to meet NRC and DOT regulations. These regulations address design and performance standards for the casks and specify radiological performance criteria for both normal transport and severe accident conditions. Compliance with these regulations is mandatory and ensures that shipments will be conducted in a manner that will ensure minimal environmental impact.

ASSOCIATED EGC ESP APPLICATION REVISIONS:
None

ATTACHMENTS:
None

NRC RAI No. E7.2-3

E7.2-3 <u>Section 7.2 (Severe Accidents)</u> - Provide a site-specific analysis of the environmental consequences of a potential severe accident at a new reactor located on the EGC ESP site using a Level 3 probabilistic risk assessment (PRA) consequence code such as the MACCS2 code. This could involve characterizing the spectrum of credible releases from candidate future plant designs, in terms of representative source terms and their respective frequencies, and using these release characteristics in conjunction with site-specific population and meteorology to determine site-specific risk impacts for the potential design. Release characteristics could be developed through a survey of severe accident analyses for previously certified advanced LWRs and/or operating reactors. The following information should be provided as part of this analysis:

a. a description of the computer code used as the basis for the calculations,including any modifications to the officially released version of the code, and important deviations from recommended or default code input values,

b. a description of the site-specific meteorology data used in the calculation, including the treatment of rain/precipitation events, and the degree to which the data represents or bounds year-to-year variations in weather at the ESP site,

c. a description of the site-specific population data used in the calculation, and justification that this data is representative of the time period through which new unit operations could extend,

d. a description of the major input assumptions for modeling economic impacts, including farm and non-farm values, evacuation costs, value of crops and milk contaminated or condemned, costs of decontamination of property, and costs associated with loss of use of property as a result of the accident (including contamination and condemnation of property),

e. a description of the protective actions considered in the evaluation, including criteria for sheltering and evacuation, criteria for interdiction and condemnation of property and/or crops, and the assumed level of medical support to aid the exposed population,

f. a description of the source terms used to represent the reference or surrogate plant design(s), including the radionuclide inventory and the release frequency and characteristics for each release category. These characteristics include release fractions for the major radionuclide groups, release times and durations, and elevation and energy of release,

g. the results of the calculations in terms of probabilistically-weighted population dose, early and latent fatalities, economic costs, and contaminated and condemned land areas, for the reference or surrogate plant design(s). Sufficient information should be provided to enable results to be displayed in a manner similar to later final environmental statements (FESs, e.g., Tables 5.10 through 5.13 in NUREG-0921), and

h. a listing of the input file for the ESP site (including population and meteorology) for the MACCS2 code.

EGC RAI ID: R3-38
REVISED EGC RESPONSE:

f. The ATMOS input data file calculates the dispersion and deposition of radiological material released (source terms) to the atmosphere as a function of downwind distance. Source term release fractions (RELFRC) for the ABWR and AP1000 are shown below, as are plume characterizations.

Two separate base case ATMOS files were developed for the ESP evaluation, one for the ABWR plant and one for the AP1000 plant. The two files are the same except for data related to:

- Core inventory
- Source term release

Table 3 summarizes pertinent file development choices and data sources for each data block section of ATMOS file. In most cases, file development utilized either the recommended data provided in the MACCS2 User's Guide (NUREG/CR-6613) or those utilized in the NUREG-1150 evaluations as documented in the NUREG/CR-4551 MACCS Input volume. It is noted that one of the five plants evaluated in NUREG/CR-4551 was the Zion Generating Station located in Illinois. Due to the regional proximity of Zion to the EGC ESP site, Zion parameters were generally utilized as the default NUREG-1150 parameters.

Table 3. ATMOS File Summary

Data Block	Description
Geometry Data	Nine radial spatial elements and 16 sectors out to 50 miles, consistent with the SITE file.
Nuclide Data	Sixty radioactive nuclides utilized in 9 groups, consistent with NUREG-1150.
Wet Deposition Data	Coefficients chosen consistent with MACCS2 User's Guide.
Dry Deposition Data	One particle size group, using NRC recommended deposition velocity of 0.01 meters/sec.
Dispersion Parameter Data	Power law model is utilized with Tadmor and Gur parameterization, consistent with NUREG-1150 and MACCS2 User's Guide.
Plume Meander Data	Expansion factors consistent with MACCS2 User's Guide.
Plume Rise Data	Scaling factors set to 1.0, consistent with MACCS2 User's Guide.
Wake Effects Data	Building dimensions taken from the ESP SSAR for the plant parameter envelope.
Release Description – Core Inventory	ABWR core inventory supplied by GE. No scaling is required. A single core (i.e., one unit) is used. AP1000 core inventory supplied by Westinghouse. A single core (i.e., one unit) is used. No scaling is required.
Release Descriptions – Source Terms	ABWR source term release fractions are based on modeling one plume and are presented in Table 4. A plume release height of 37.7m is used (the ABWR utilizes a rupture disc design) along with buoyant plume rise heat values developed by GE and are presented in Table 5. AP1000 source term release fractions are based on modeling two plumes and are presented in Table 6. A plume release height of 10m was assumed (see table 7), consistent with the EGC ESP SSAR, and buoyant plume rise was conservatively neglected.
Meteorological Sampling	Weather category bin sampling using 12 samples/bin (NUREG-1150 used only 4 samples/bin).

The reactor vendor supplied the Level 2 data. This data included the source term inventory, power level, release fractions, plume start time, plume release height, delay, and dilution.

The ABWR shows 10 different source term categories (STCs) [Table 4]. The release times and durations and elevation and energy of release for the ABWR were extracted form the GE ABWR licensing submittal document. Parameters are assigned to each source term according to an STC number. Each release plume is assumed to have one segment (Table 5).

The vendor provided the AP1000 radionuclide inventory, as well as the source term category release fractions and corresponding frequencies for the MACCS2 element groups. Four plume segments of release fraction data were originally reported, but were collapsed to two in order to satisfy the limitations of the MACCS2 code. Shown in the table below are the collapsed source term release fractions for the different STCs (Table 6).

Timing data indicated in Table 7 below was also revised to reflect two plume segments. A plume release height was selected to be 10 meters. The ALARM time was selected to be the same as the first plume delay time. The balance of the timing data of each plume are taken from the Westinghouse PRA study document.

Table 4. ABWR Source Term Release Fraction

STC	Xe/Kr	I-Br	Cs-Rb	Te-Sb	Sr	Co-Mo	La	Ce	Ba
ST1 – Case 0	4.4E-02	2.3E-05	2.3E-05	5.0E-06	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
ST2 – Case 1	1.0E+00	1.5E-07	1.3E-05	3.1E-04	6.3E-06	2.4E-11	7.9E-08	7.9E-08	6.3E-06
ST3 – Case 2	1.0E+00	5.0E-06	5.0E-06	0.0E+00	0.0E+00	0 0E+00	0.0E+00	0.0E+00	0.0E+00
ST4 – Case 3	1.0E+00	2.8E-04	2.2E-03	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
ST5 – Case 4	1.0E+00	1.6E-03	1.6E-03	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
ST6 – Case 5	1.0E+00	6.0E-03	5.3E-04	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
ST7 – Case 6	1 0E+00	3.1E-02	7.7E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
ST8 – Case 7	1.0E+00	8.9E-02	9 9E-02	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
ST9 – Case 8	1.0E+00	1.9E-01	2.5E-01	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00	0.0E+00
ST10 – Case 9	1.0E+00	3.7E-01	3.6E-01	1.1E-03	9.3E-03	9.2E-08	2.8E-03	2.8E-03	9.3E-03

Table 5. ABWR Plume Characterization Data

STC	OALARM (s)	NUMREL	MAXRIS	REFTIM (s)	PLHEAT (w)	PLHITE (m)	PLDUR (s)	PDELAY (s)
0	6120	1	1	0	1.38E+06	37.7	36000	9720
1	69120	1	1	0	1.38E+06	37.7	3600	72000
2	65520	1	1	0	1.38E+06	37.7	3600	68400
3	177120	1	1	0	1.38E+06	37.7	36000	180000
4	69120	1	1	0	1.38E+06	37.7	3600	72000
5	65520	1	1	0	1.38E+06	37.7	3600	68400
6	65520	1	1	0	1.38E+06	37.7	36000	68400
7	69120	1	1	0	1.38E+06	37.7	36000	72000
8	4320	1	1	0	4.19E+06	37.7	36000	7200
9	43920	1	1	0	1.38E+06	37.7	36000	84960

Table 6. AP1000 SOURCE TERM RELEASE FRACTIONS

STC	Plume	Xe/Kr	I-Br	Cs-Rb	Te-Sb	Sr	Ru	La	Ce	Ba
CFI	Plume 1	7.98E-01	3.33E-03	3.32E-03	4.35E-04	2.18E-02	9.28E-03	8.06E-03	4.32E-05	1.65E-02
	Plume 2	1.22E-01	0.00E+00	0.00E+00	6.04E-06	0.00E+00	0.00E+00	1.12E-02	4.06E-05	0.00E+00
CFE	Plume 1	8.21E-01	5.66E-02	5.49E-02	1.39E-03	3.48E-03	1.42E-02	6.54E-05	1.00E-06	5.28E-03
	Plume 2	1.42E-01	0.00E+00	0.00E+00	6.04E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
IC	Plume 1	1.48E-03	1.20E-05	1.15E-05	8.09E-07	1.07E-05	1.31E-05	1.36E-06	5.88E-09	1.20E-05
	Plume 2	1.17E-03	0.00E+00	0.00E+00	1.81E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
BP	Plume 1	1.00E+00	2.15E-01	1.96E-01	9.84E-03	3.57E-03	4.48E-02	1.30E-04	3.19E-06	8.93E-03
	Plume 2	0.00E+00	2.34E-01	7.60E-02	6.89E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	1.00E-06
CI	Plume 1	6.86E-01	4.56E-02	2.10E-02	1.65E-03	2.03E-02	4.04E-02	2.39E-04	2.97E-06	3.16E-02
	Plume 2	8.40E-02	0.00E+00	0.00E+00	9.37E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
CFL	Plume 1	1.53E-03	1.21E-05	1.15E-05	1.02E-06	1.67E-05	1.71E-05	1.17E-05	4.79E-08	1.68E-05
	Plume 2	9.79E-01	2.13E-05	1.19E-05	3.67E-05	2.83E-03	1.42E-03	1.41E-01	5.34E-04	2.60E-03

Table 7. AP1000 Collapsed Plume Characterization Data

STC	OALARM (S)	NUMREL	MAXRIS	REFTIM (s)	PLHEAT (w)	PLHITE (m)	PLDUR (s)	PDELAY (s)
CFI	2924	2	1	0.0	0	10	53830	2924
				0.5	0	10	86400	32590
CFE	3004	2	1	0.0	0	10	70160	3004
				0.5	0	10	86400	19810
IC	4378	2	1	0.0	0	10	80432	4378
				0.5	0	10	86400	84810
BP	31890	2	1	0.5	0	10	40050	31890
				0.0	0	10	86400	46440
CI	100.8	2	1	0.5	0	10	86380	100.8
				0.5	0	10	75300	50020
CFL	2922	2	1	0.5	0	10	81640	2922
				0.5	0	10	86400	26360

Responses to Environmental RAIs

Responses to the following environmental RAIs are provided in this enclosure:

E3.8-15

E9.2-1

NRC Letter Dated: 08/23/04

NRC RAI No. E3.8-15

E3.8-15 The environmental impacts of the transportation of fuel and radioactive wastes to and from nuclear power facilities were resolved generically for light water reactor in 10 CFR 51.52(a) provided that the specific conditions in the rule are met; if not, a full description and detailed analysis is required from the applicant for initial licensing in accordance with 10 CRR 51.52(b). Once licensed, the NRC may consider requests to operate at conditions above those in the facility's licensing basis; for example, higher burnups, enrichments, or thermal power levels above 33,000 MWd/MTU, 4 percent, and 3800 MW(t), respectively. The rule has not been changed for the initial licensing of nuclear power facilities, and departures from the conditions itemized in the rule were found to be acceptable for licensed facilities cannot serve as the basis for initial licensing. Unless the applicant uses a plant parameters envelope for considering transportation impacts, each reactor must be considered separately.

Provide a transportation risk assessment for all proposed light reactors spent fuel shipments using an accepted methodology such as RADTRAN V. Provide justification that the best available information has been used to generate the RADTRAN input values and that those values are appropriate for the light water reactors proposed. Provide a comparison of the results of that assessment with the spent fuel shipment risk estimates contained in NUREG-0170, *Final Environmental Statement on the Transportation of Radioactive Material by Air and Other Modes.*

EGC RAI ID: 15-1

EGC RESPONSE:

A transportation risk assessment using RADTRAN V was conducted for three LWR technologies: ABWR, AP-1000, and ACR-700, which were determined to be representative of all of the LWR technologies that form the basis of the plant parameter envelop. The analysis assumed that the spent fuel truck shipments would be shipped from the Maine Yankee Nuclear Plant to Yucca Mountain. The TRAGIS Routing Engine Version 1.4.15, which uses the 2000 Census data, provided the routing information and the population densities. The input values were taken primarily from the Yucca Mountain Final EIS, in particular the *Transportation Health and Safety Calculation/Analysis Documentation in Support of the Final EIS for the Yucca Mountain Repository*. Specifically the values for the BWR and PWR accident severity and release fractions were taken from Tables 5-24 and 5-25 of the aforementioned reference. For the ACR-700, the PWR input values were used. The comparisons of the incident free results with NUREG-0170 are shown in Table 1.

Table 1.
LWR RADTRAN V Incident Free Analysis Results as Compared to NUREG-0170

	NUREG-0170[1] (person-rem/shipment)	ABWR[2] RADTRAN V results (person-rem/shipment)	AP-1000[2] RADTRAN V results (person-rem/shipment)	ACR-700[2] RADTRAN V results (person-rem/shipment)	Difference between RADTRAN V results and NUREG-0170
Passengers	0	0	0	0	0
Crew	0.123	0.157	0.157	0.157	0.034
Handlers	0.2	0.188	0.188	0.188	-0.012
Off-Link	0.015	0.012	0.012	0.012	-0.003
On-Link	0.007	0.081	0.081	0.081	0.073
Stops	0.019	0.190	0.190	0.190	0.171
Storage	0.005	0	0	0	-0.005
Total	0.369	0.628	0.628	0.628	0.259

Notes:
(1) - Based on 1530 spent fuel truck shipments for the year 1985
(2) - Spent Fuel shipment from Maine Yankee to Yucca Mountain

The results are the same for the three reactors because the incident-free dose to a receptor is independent of the isotopic contents of the cask, depending only on the dose rate external to the cask, which was set at the regulatory limits.

The major differences between the NUREG 0170 and the RADTRAN results are attributed to the dose incurred during stops ("stop dose"), and to a lesser degree the dose to the crew and the on-link dose. Approximately 42% of the stop dose difference is attributable to the RADTRAN V simulations, which includes inspections at the beginning and the end of the trip, whereas NUREG-0170 did not include these inspections. The remaining difference can be attributed to greater distance traveled, hence more refueling stops, and the different methodologies used to calculate the stop doses. This evaluation used 1996 truck stop data (*Investigation of Radtran Stop Model Input Parameters for Truck Stops*, SAND96-0714C) (the "Stop Model") modeled public doses in two concentric rings: 1m to 14m and 30m to 800m. The population in the inner ring is based on the results of the Stop Model study, while the population in the outer ring is based on route specific 2000 Census population data weighted by a 3% urban, 26% suburban and 71% rural distribution. The NUREG-0170 study modeled just one ring, 10 to 2600 feet, and used three fixed population densities.

Factors contributing to the greater crew dose include the greater distance traveled and more refueling stops.

Factors contributing to the increased on-link population dose are the result of NUREG-0170 assuming a 2,500 km shipment distance with a 5% urban, 5% suburban and 90% rural population versus this evaluation using updated 2000 census information showing a 3% urban, 26% suburban and 71% rural population and a 4,733 km shipment distance.

In addition to the incident free results, the RADTRAN V runs also included accident results. A comparison with NUREG-0170 is shown in Table 2 below.

Table 2.
LWR RADTRAN V Accident Risk Analysis Results as Compared to NUREG-0170

	Table 5-10, NUREG-0170, 1985,	RADTRAN V, ABWR	RADTRAN V, AP-1000	RADTRAN V, ACR-700
Person-rem	NA	1.13E-05	2.42E-07	1.21E-07
Latent Cancer Fatalities[(1)]	0.29	1.78E-02	3.82E-04	1.91E-04

Notes:

(1)- The conversion from the RADTRAN V person-rem results to latent cancer fatalities was completed utilizing a dose conversion factor of 6.3E-4 rem/LCF contained in the report: *BEIR V "Health Effects of Exposure to Low Levels of Ionizing Radiation"*

The RADTRAN V accident results are 16 times (for the ABWR) to over 1,500 times (for the ACR-700) lower than the results presented in NUREG-0170.

ASSOCIATED EGC ESP APPLICATION REVISIONS:

None

ATTACHMENTS:

None

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

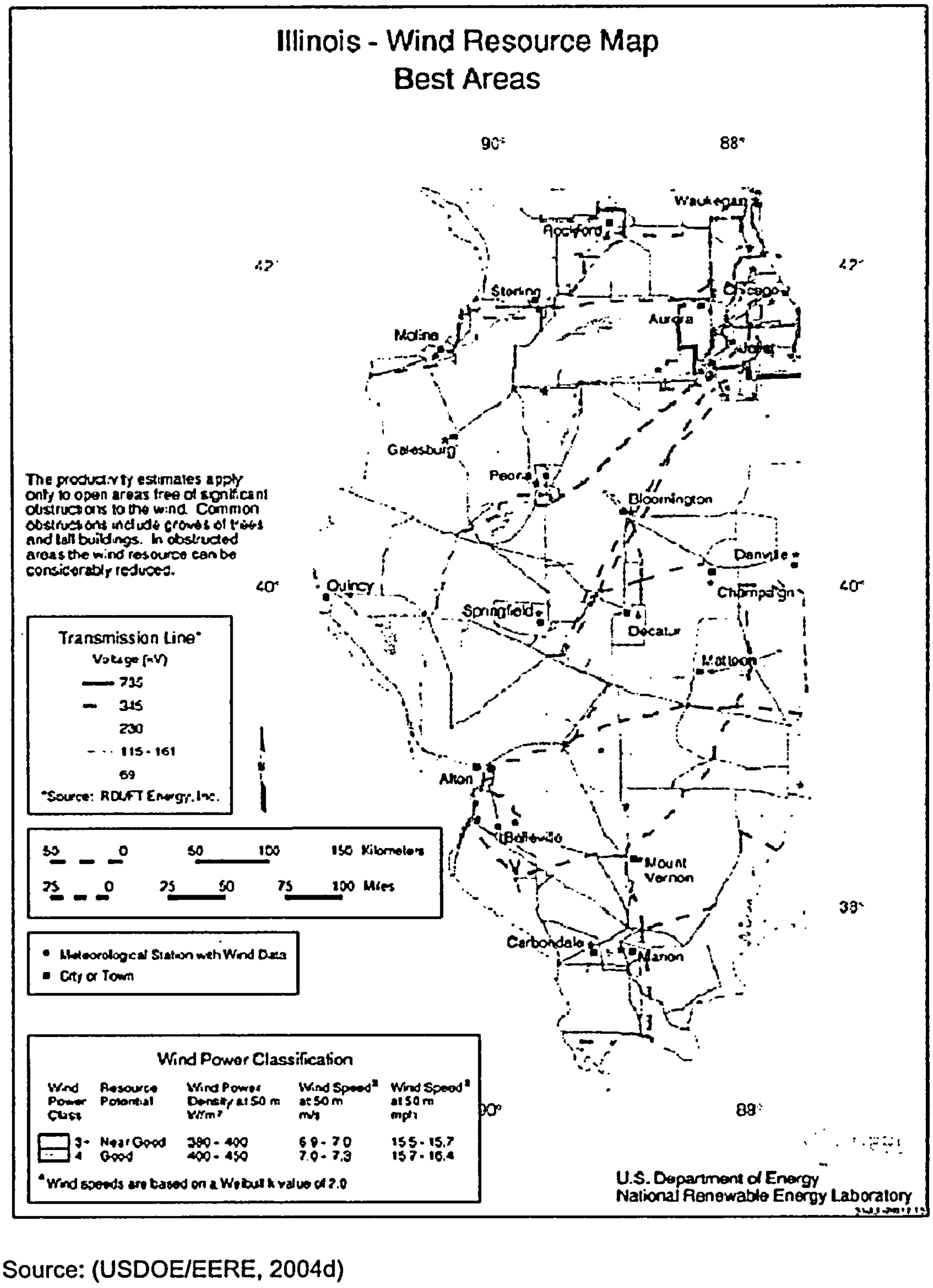
Wind and solar facilities in combination with fossil facilities could be used to generate baseload power and would serve the purpose of the EGC ESP Facility. However, wind and solar facilities in combination with fossil facilities would have equivalent or greater environmental impacts relative to a new 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

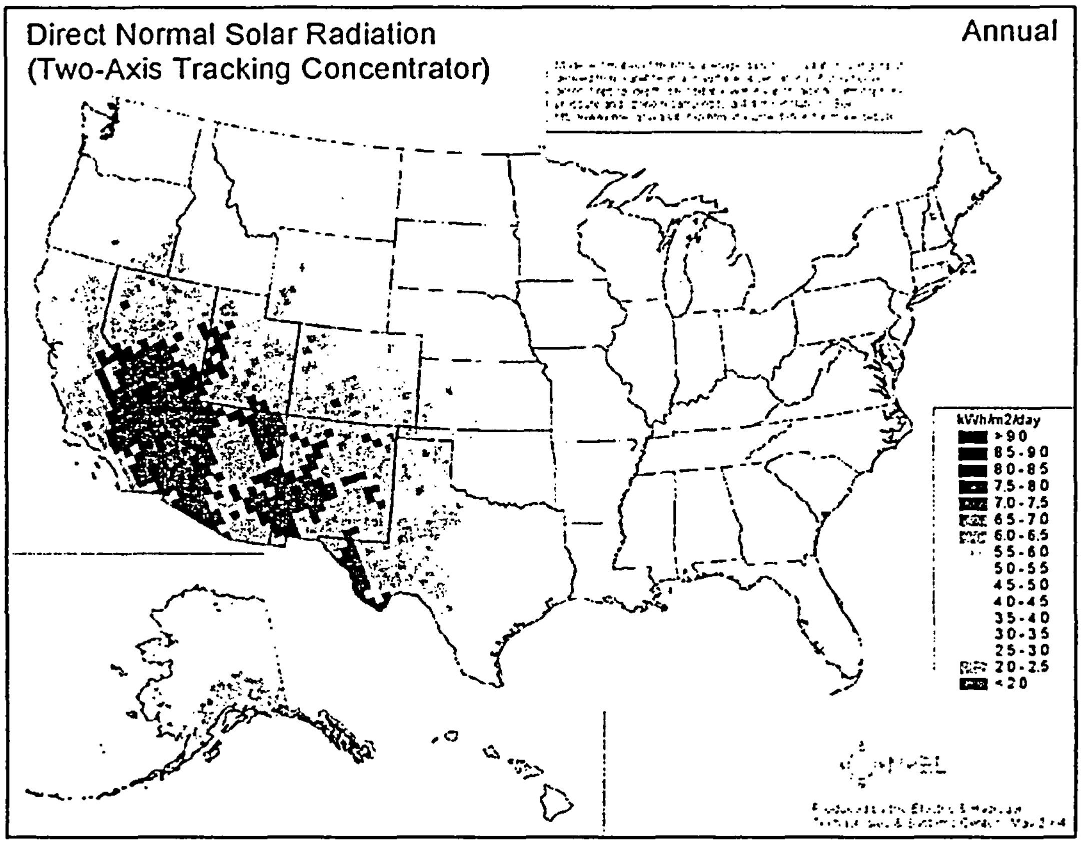
As shown in detail in Tables 9.2-6 and 9.2-7, based on environmental impacts, EGC has determined that neither a coal-fired, nor a gas-fired, nor a combination of alternatives, including wind and solar facilities, would provide an appreciable reduction in overall environmental impact relative to a nuclear 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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