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Here is the staff/applicant/intervenor submittals and NRC/Applicant exhibit lists.
I'll keep you and Jack in the loop.
Laura

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	
	)	
CALVERT CLIFFS 3 NUCLEAR PROJECT,	)	
LLC AND UNISTAR NUCLEAR	)	Docket No. 52-016
OPERATING SERVICES, LLC	)	
	)	
(Calvert Cliffs Nuclear Power Plant, Unit 3)	)	

UNISTAR INITIAL STATEMENT OF POSITION ON CONTENTION 10C

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Dated at Washington, District of Columbia
this 21st day of October 2011

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	
	)	
CALVERT CLIFFS 3 NUCLEAR PROJECT, LLC AND UNISTAR NUCLEAR OPERATING SERVICES, LLC	)	Docket No. 52-016-COL
	)	
(Calvert Cliffs Nuclear Power Plant, Unit 3)	)	

UNISTAR INITIAL STATEMENT OF POSITION ON CONTENTION 10C

I. INTRODUCTION

Pursuant to 10 C.F.R. § 2.1207(a)(1), the Licensing Board's Order (Revising Initial Schedule), dated June 24, 2011, and the Order (Providing Direction on Pre-filed Evidentiary Material), dated September 22, 2011, Calvert Cliffs 3 Nuclear Project and UniStar Nuclear Operating Services (collectively, "UniStar") hereby submit this Initial Statement of Position on Contention 10C. This Initial Statement of Position is supported by direct testimony from Dimitri Lutchenkov, Stefano Ratti, and Septimus van der Linden ("UniStar Testimony") and the exhibits submitted with this Initial Statement of Position. For the reasons set forth below, the NRC Staff analysis of energy alternatives in the Final Environmental Impact Statement for Calvert Cliffs 3 ("FEIS")[1] satisfies the requirements of the National Environmental Policy Act ("NEPA"). Contention 10C should be resolved in favor of UniStar and the NRC Staff.

[1] Environmental Impact Statement for the Combined License (COL) for Calvert Cliffs Nuclear Power Plant Unit 3, Final Report, NUREG-1936 (May 2011) (ADAMS Accession Nos. ML11129A167, ML1129A179) (Exhs. NRC00003A and NRC00003B).

II. SUMMARY OF ARGUMENT

In its Environmental Report ("ER"), UniStar identified the project purpose, which was to produce 1600 MW(e) of baseload power in Maryland. In the FEIS, the NRC Staff accepted the purpose of the project and confirmed a need for the power that would be generated by Calvert Cliffs 3. As required by NEPA, the NRC Staff considered a range of energy alternatives that could satisfy that need for power and the project purpose (*i.e.*, baseload generation). The energy alternatives considered included coal-fired generation, natural gas, and a combination of alternatives (a mix of renewables, in conjunction with energy storage, and natural gas), in addition to nuclear. These alternatives and their environmental impacts were fully discussed in the FEIS.

Based on the FEIS discussion of energy alternatives, the NRC Staff has taken the requisite hard look at the significant environmental considerations associated with energy alternatives and has "come to grips with all important considerations."[2] The hypothetical combination of energy alternatives, including wind and solar, in conjunction with energy storage, and natural gas, selected by the NRC Staff is reasonable and would satisfy the purpose and need for the proposed action (1600 MW(e) of additional baseload power in Maryland). As discussed in the FEIS, and as supplemented by the testimony and exhibits introduced in this hearing, no reasonable combination of energy alternatives is environmentally preferable to the proposed action — even accounting for some uncertainty in the amount of baseload energy that could be produced using wind or solar, in conjunction with energy storage, and in combination with natural gas. The FEIS satisfies Part 51 and NEPA. Contention 10C should be resolved in favor of UniStar and the NRC Staff.

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[2] *Exelon Generation Co., LLC* (Early Site Permit for Clinton ESP Site), CLI-05-29, 62 NRC 801, 811 (2005).

III. PROCEDURAL BACKGROUND

In April 2010, the NRC Staff issued the Draft Environmental Impact Statement ("DEIS") for Calvert Cliffs 3.[3] Joint Intervenors filed proposed Contention 10 on June 25, 2010, challenging the adequacy of the NRC Staff's analyses of the need for power, energy alternatives, and costs.[4] Contention 10, as proposed by Joint Intervenors, stated:

> The Draft Environmental Impact Statement (DEIS) is inadequate to meet the requirements of 10 CFR 51.71(d) or provide reasonable support for the NRC's decision on issuance of a construction/operating license for the proposed Calvert Cliffs-3 nuclear reactor because its analyses of Need for Power, Energy Alternatives and Cost/Benefit analysis (Chapters 8, 9 and 10) are flawed and based on inaccurate, irrelevant and/or outdated information.[5]
>
> <u>Bases</u>
>
> A. The DEIS's Analysis of Need for Power is Inadequate and Based on Faulty and Outdated Information.
>
> B. The DEIS's Discussion of Energy Alternatives is Inadequate, Faulty and Misleading.
>
> C. The DEIS's Discussion of a Combination of Alternatives is Inadequate and Faulty.
>
> D. The DEIS's Discussion of Costs Both Understates Likely Costs and Disputes Cost Estimates in the Applicants' ER, Calling into Question the ER's discussion of Calvert Cliffs-3 vs. Alternatives.

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3 *See* Notice of Availability of the Draft Environmental Impact Statement for the Combined License Application for Calvert Cliffs Nuclear Power Plant Unit 3, 75 Fed. Reg. 20,867 (Apr. 21, 2010); "Environmental Impact Statement for the Combined License (COL) for Calvert Cliffs Nuclear Power Plant Unit 3, Draft Report for Comment," NUREG-1936 (April 2010) (ADAMS Accession Nos. ML101000012 and ML101000013) ("DEIS") (Exh. APL000050).

4 *See* "Submission of Contention 10 by Joint Intervenors," dated June 25, 2010 ("Contention 10"). UniStar and the NRC Staff filed responses to proposed Contention 10 on July 20, 2010. *See* "Applicants' Response to Proposed Contention 10," dated July 20, 2010 ("UniStar Response"); "NRC Staff Answer to Joint Intervenors' New Contention 10," dated July 20, 2010 ("NRC Staff Answer").

5 Contention 10 at 1.

In LBP-10-24, dated December 28, 2010, the Licensing Board addressed the admissibility of Contention 10 by dividing it into four distinct parts linked to each of the four bases (Contentions 10A-10D). The Licensing Board found that Contentions 10A, 10B, and 10D were inadmissible. However, the Licensing Board found that Contention 10C, as restated, was admissible.

Contention 10C asserted that Section 9.2.4 of the DEIS, which addressed a combination of alternatives to Calvert Cliffs 3, was inadequate because the NRC failed to correctly address the wind and solar power potential for Maryland or examine the impact of demand-side programs.[6] Specifically, the Intervenors asserted that, while the NRC Staff assumed a contribution from all wind power sources of only 100 MW, the proposed Bluewater Wind project alone would provide 600 MW of power.[7] The Intervenors additionally argued that, "[b]y failing to even attempt to quantify potential power from solar photovoltaics, the DEIS has no basis whatsoever for assuming a 75 MW contribution from solar power."[8] Intervenors contended that "a feasible combination of alternatives might well include a considerably smaller natural gas plant than contemplated in the DEIS, along with a much larger contribution from renewable sources of power and demand-side programs."[9]

According to the Board, the Intervenors provided sufficient facts to support their claim that there were inaccuracies in the DEIS analysis of the combination alternative and its

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6 *Id.* at 9.

7 *Id.*

8 *Id.* at 10.

9 *Id.*

environmental consequences.[10] The Board concluded that the Intervenors had identified facts to show that Maryland may have significant offshore wind potential that the discussion of the combined alternative in the DEIS ignored.[11] The Board also found sufficient the Intervenors' reference to solar power potential in Maryland, which it contrasted with the lack of an explanation in the DEIS for assuming a contribution of only 75 MW(e) from solar power.[12] According to the Board, "Intervenors are simply suggesting that the Staff explore a combination that would include greater contributions from wind and solar power."[13] Therefore, "[t]he NRC Staff would have to revise the alternatives analysis to include more accurate estimates of the potential contribution of wind and solar power to the combined alternative."[14]

The Board rejected the Intervenors' arguments regarding demand-side management, explaining that Contention 10C is limited to the allegations that the combined alternative underestimates the potential contributions to baseload of wind and solar power.[15] The admitted contention was therefore limited to (1) the DEIS's failure to acknowledge the potential for wind energy production in excess of 100 MW(e); and (2) the DEIS's failure to discuss the basis for assuming a contribution of only 75 MW(e) from solar power. Ultimately, the Board admitted the revised Contention 10C as follows:

> The DEIS discussion of a combination of alternatives is inadequate and faulty. By selecting a single alternative that under represents potential

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10 LBP-10-24 at 51.

11 *Id.*

12 *Id.*

13 *Id.* at 54.

14 *Id.* at 52.

15 *Id.* at 45 n.81.

> contributions of wind and solar power, the combination alternative depends excessively on the natural gas supplement, thus unnecessarily burdening this alternative with excessive environmental impacts.[16]

On May 20, 2011, the NRC Staff published the Final Environmental Impact Statement ("FEIS") for the Calvert Cliffs 3 COL.[17] Following publication of the FEIS, the NRC Staff and Intervenors filed a Joint Motion Regarding Scheduling, proposing a deadline of June 20, 2011, for the filing of motions for summary disposition of Contention 10C and for the filing of new or amended contentions based on the FEIS. UniStar agreed to this deadline. On June 20, 2011, UniStar filed its Motion for Summary Disposition of Contention 10C and Intervenors filed their Submission of Amended Contention 10C. On July 11, 2011, the NRC Staff filed a response in support of summary disposition.

The Board issued its decision on summary disposition on August 26, 2011.[18] The Board found that although the NRC Staff updated the FEIS to include additional information regarding wind and solar power contributions to the combined baseload alternative presented in the DEIS, this information did not resolve the factual dispute concerning the reasonableness of those estimates. With respect to wind contributions, the Board determined that material factual disputes remain as to Maryland's wind power potential and the possible future availability of compressed air energy storage ("CAES") systems in Maryland. With respect to solar power, the Board noted two recently-announced Maryland solar projects relied upon by the Intervenors, as

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16 *Id*. at 54.

17 Calvert Cliffs 3 Nuclear Project, LLC and UniStar Nuclear Operating Services, LLC; Notice of Availability of the Final Environmental Impact Statement for the Combined License Application for Calvert Cliffs Nuclear Power Plant Unit 3, 76 Fed. Reg. 29,279 (May 20, 2011).

18 Memorandum and Order (Denying Summary Disposition of Contention 10C, Denying Amended Contention 10 C, and Deferring Ruling on Contention 1), dated August 26, 2011.

well as the Affidavit from Scott Sklar, which asserts an increasing market for solar power in the future. The Board found these facts and sources sufficient to show a genuine dispute concerning the adequacy of the NRC's wind and solar contribution estimates for the combined alternative. Accordingly, these issues must be resolved through hearing.

The Board also denied the Intervenors' Amended Contention 10C as unnecessary under the "migration tenet," which allows an admitted contention contesting a DEIS to be construed as a challenge to the subsequently issued FEIS. However, the Board found that the Intervenors' supplemental arguments concerning the need for baseload power, the region of interest ("ROI"), demand side management, and costs of construction are outside the scope of Contention 10C.

IV. APPLICABLE LEGAL STANDARDS

A. National Environmental Policy Act

Contention 10C raises environmental issues under NEPA. NEPA requires that federal agencies, such as the NRC, prepare an EIS for "major Federal actions significantly affecting the quality of the human environment."[19] NEPA does not mandate substantive results; rather, it imposes procedural restraints on agencies, requiring them to take a "hard look" at the environmental impacts of a proposed action and reasonable alternatives to that action.[20] This "hard look" is subject to a "rule of reason."[21] This means that an "agency's environmental

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19 42 U.S.C. § 4332(2)(C).

20 *See Louisiana Energy Servs., L.P.* (Claiborne Enrichment Ctr.), CLI-98-3, 47 NRC 77, 87-88 (1998); *see also Balt. Gas & Elec. Co. v. NRDC*, 462 U.S. 87, 97-98 (1983) (holding that NEPA requires agencies to take a "hard look" at environmental consequences prior to taking major actions).

21 *Louisiana Energy Servs.* (National Enrichment Facility), LBP-06-8, 63 NRC 241, 258-59 (2006) (*citing Long Island Lighting Co.* (Shoreham Nuclear Power Station), ALAB-156, 6 AEC 831, 836 (1973)); *see also Dep't of Transp. v. Pub. Citizen*, 541 U.S. 752, 767-69

review, rather than addressing every impact that could possibly result, need only account for those that have some likelihood of occurring or are reasonably foreseeable."[22] Consideration of "remote and speculative" events is not required.[23]

As the Commission has explained, "NEPA also does not call for certainty or precision, but an *estimate* of anticipated (not unduly speculative) impacts."[24] When faced with uncertainty, NEPA only requires "reasonable forecasting."[25] There is no NEPA requirement to use the best scientific methodology, and NEPA should be construed in the light of reason if it is not to demand virtually infinite study and resources.[26] An EIS is not intended to be a "research document," reflecting the frontiers of scientific methodology, studies and data.[27] Nor must the discussion of the impacts be encyclopedic in scope or detail. NEPA does not require agencies to use technologies and methodologies that are still "emerging" and under development.[28] Likewise, NEPA analyses often must rely upon imprecise and uncertain data, particularly when forecasting future technological developments, which should be judged on their

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(2004) (stating that the rule of reason is inherent in NEPA and its implementing regulations).

22 *LES*, LBP-06-8, 63 NRC at 258-59 (*citing Shoreham*, ALAB-156, 6 AEC at 836).

23 *See Vt. Yankee Nuclear Power Corp.* (Vermont Yankee Nuclear Power Station), ALAB-919, 30 NRC 29, 44 (1989) (citing *Limerick Ecology Action, Inc. v. NRC*, 869 F.2d 719, 739 (3d Cir. 1989)).

24 *Louisiana Energy Servs.* (Nat'l Enrichment Facility), CLI-05-20, 62 NRC 523, 536 (2005).

25 *Scientists' Inst. for Pub. Info., Inc. v. AEC*, 481 F.2d 1079, 1092 (D.C. Cir. 1973).

26 *Entergy Nuclear Generation Co.* (Pilgrim Nuclear Power Station), CLI-10-11, 71 NRC __, slip op. at 37 (Mar. 26, 2010) (citations omitted).

27 *Id.*

28 *Id.*

reasonableness.[29] And while there "will always be more data that could be gathered," agencies "must have some discretion to draw the line and move forward with decisionmaking."[30] Ultimately, NEPA allows agencies "to select their own methodology as long as that methodology is reasonable."[31]

The Commission has also stated that the principal goals of the FEIS are "to force agencies to take a 'hard look' at the environmental consequences of a proposed project, and, by making relevant analyses openly available, to permit the public a role in the agency's decision-making process."[32] While NEPA procedural dictates are almost certain to affect the agency's substantive decision, "it is now well settled that NEPA itself does not mandate particular results, but simply prescribes the necessary process."[33] Thus, the NRC Staff need not select the alternative with the least environmental impacts, but rather must only include in its NEPA evaluation sufficient information to satisfy one of NEPA's essential functions — to provide the public and the decision maker with accurate information comparing the proposed action and its alternatives.[34] NRC licensing boards do not sit to "flyspeck" the FEIS or to add minor details or

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29 *Louisiana Energy Servs.* (Claiborne Enrichment Center), LBP-96-25, 44 NRC 331, 355 (1996).

30 *Id*.

31 *Hughes River Watershed Conservancy v. Johnson,* 165 F.3d 283, 289 (4th Cir. 1999).

32 *Louisiana Energy Services* (Claiborne Enrichment Center), CLI-98-3, 47 NRC 77, 87 (1998).

33 *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 350 (1989).

34 *Calvert Cliffs 3 Nuclear Project LLC and UniStar Nuclear Operating Services LLC* (Calvert Cliffs Nuclear Power Plant, Unit 3), LBP-10-24, __ NRC __, __ (slip op. at 50) (December 28, 2010).

nuances to the analysis.[35] It is enough that the FEIS discusses the significant aspects of the probable environmental impacts of the proposed action.[36]

B. Burden of Proof

An applicant generally has the burden of proof in a licensing proceeding.[37] However, in cases involving NEPA contentions, the burden belongs to the NRC Staff because the NRC Staff, not the applicant, has the responsibility for complying with NEPA.[38] However, because "the Staff, as a practical matter, relies heavily upon the Applicant's ER in preparing the [Environmental Impact Statement ("EIS")], should the Applicant become a proponent of a particular challenged position set forth in the EIS, the Applicant, as such a proponent, also has the burden on that matter."[39]

The showing necessary to meet the burden of proof is the "preponderance of the evidence" standard.[40] NRC administrative proceedings have generally relied upon the preponderance standard in reaching the ultimate conclusions after a hearing to resolve the

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[35] *Hydro Resources, Inc.* (P.O. Box 15910, Rio Rancho, NM 87174), CLI-01-04, 53 NRC 31, 71 (2001).

[36] *Long Island Lighting Company* (Shoreham Nuclear Power Station), ALAB-156, 6 AEC 831, 836 (1973).

[37] 10 C.F.R. § 2.325.

[38] *See, e.g.*, Duke Power Co. (Catawba Nuclear Station, Units 1 & 2), CLI-83-19, 17 NRC 1041, 1049 (1983).

[39] *Louisiana Energy Servs., L.P.* (Claiborne Enrichment Center), LBP-96-25, 44 NRC 331, 338-39 (1996) (citing *Pub. Serv. Co. of N.H.* (Seabrook Station, Units 1 & 2), ALAB-471, 7 NRC 477, 489 n.8 (1978)), *rev'd on other grounds*, CLI-97-15, 46 NRC 294 (1997).

[40] The definition of "preponderance of the evidence" in Black's Law Dictionary, 6th ed. (p. 1182), is "[e]vidence which is of greater weight or more convincing than the evidence offered in opposition to it; that is, evidence which as a whole shows that the fact sought to be proved is more probable than not."

proceeding.[41] Thus, the Licensing Board must consider the evidence and testimony and determine whether the NRC Staff and UniStar has shown by the preponderance of the evidence that the NRC Staff's review was adequate to comply with NEPA.

C. Record of Decision

In determining whether the FEIS should have included additional information, the Board may consider the record as a whole. Commission precedent holds that the adjudicatory record and the Licensing Board decision become part of the record of decision.[42] In NRC licensing proceedings, "the ultimate NEPA judgments regarding a facility can be made on the basis of the entire record before a presiding officer, such that the EIS can be deemed amended pro tanto."[43] Therefore, the Board may consider the full record before it, including the testimony and exhibits at the hearing, to conclude that "the aggregate is sufficient to satisfy the agency's obligation under NEPA" to take a "hard look" at the environmental consequences of issuing a combined license ("COL").[44]

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41 *Advanced Medical Systems, Inc.* (One Factory Row, Geneva, Ohio 44041), CLI-94-6, 39 NRC 285 (1994), *aff'd*, *Advanced Medical Systems, Inc. v. NRC*, 61 F.3d 903 (6th Cir. 1995); *see also Commonwealth Edison Co.* (Zion Station, Units 1 & 2), ALAB-616, 12 NRC 419, 421 (1980) (stating that applicants are not held to an absolute standard or required to prove a matter conclusively but rather, consistent with the Administrative Procedure Act, are held to a preponderance standard).

42 *See, e.g.*, *Louisiana Energy Servs.* (National Enrichment Facility), CLI-06-15, 63 NRC 687, 707 n. 91 ("Adjudicatory findings on NEPA issues, including our own in this decision, become part of the environmental 'record of decision' and in effect supplement the FEIS."); *LES*, CLI-98-3, 47 NRC at 89 ("In NRC licensing adjudications … it is the Licensing Board that compiles the final environmental 'record of decision' . . . . The adjudicatory record and Board decision . . . become, in effect, part of the FEIS.").

43 *Louisiana Energy Servs.* (National Enrichment Facility), LBP-05-13, 61 NRC 385, 404 (2005).

44 *LES*, LBP-06-8, 63 NRC at 286.

V. APPLICANT WITNESSES

UniStar's Direct Testimony on Contention 10C is presented by Mr. Dimitri Lutchenkov, Mr. Stefano Ratti, and Mr. Septimus van der Linden. Through the attached testimony and supporting exhibits, UniStar's expert witnesses demonstrate that that the NRC Staff's estimates of the potential contribution to baseload generation of wind and solar, in conjunction with energy storage, and in combination with natural gas, are reasonable and realistic. The witnesses also confirm that the combination of energy alternatives is not environmentally preferable to Calvert Cliffs 3, even accounting for a greater contribution to baseload power from wind and solar, in conjunction with energy storage.

A. Dimitri Lutchenkov

Mr. Lutchenkov is the Director, Environmental Affairs and Special Projects, for UniStar Nuclear Energy, LLC. In this position at UniStar, he has responsibility for the environmental aspects of the Calvert Cliffs 3 licensing reviews. Mr. Lutchenkov provides an overview of the need for power from the proposed Calvert Cliffs 3 and explains the logic and methodology of the NRC Staff's assessment of energy alternatives in the FEIS. Mr. Lutchenkov testifies that the various energy alternatives, including the combination of alternatives, are not environmentally preferable to the proposed action. Mr. Lutchenkov concludes that, even with a significantly greater contribution to baseload power from wind and solar, in conjunction with energy storage, the combination of alternatives is not environmentally preferable.

B. Stefano Ratti

Mr. Ratti was responsible for several years for developing strategic renewable initiatives, including evaluation of potential acquisitions in the renewable energy sector and creation of renewable energy businesses in the United States. Based on his experience, Mr. Ratti provides an overview of the current state of wind and solar power generation development in

Maryland and beyond. His testimony addresses the key considerations applicable to wind and solar projects and discusses the various factors that affect deployment of wind and solar generation resources. Mr. Ratti concludes that that the relative contributions of wind and solar power to the combination of alternatives in the FEIS are reasonable (100 MW(e) for wind and 75 MW(e) for solar). He further concludes that assuming significantly greater contributions from wind and solar than those considered in the FEIS would be unreasonable.

C. Septimus van der Linden

Mr. van der Linden has over 30 years experience with CAES and is familiar with the design concepts of the first commissioned CAES plant in Huntorf, Germany. Mr. van der Linden was involved in the design and application aspects of CAES plant and technology in the United States and participated in many EPRI-lead workshops that led to construction of the first domestic CAES plant at McIntosh, Alabama. Mr. van der Linden provides an overview of the current state of CAES in Maryland, the United States, and internationally. Mr. van der Linden concludes that, while it is possible that wind, in conjunction with CAES, could generate 100 MW(e) of "baseload" wind power in the next 10 years, it is highly unlikely given the current state of CAES technology and development in Maryland. Similarly, Mr. van der Linden concludes that, while it is possible that solar, in conjunction with CAES, could generate 75 MW(e) of " baseload" solar power in the next decade, it is unlikely given the current state of CAES technology and development in Maryland. On balance, Mr. van der Linden concludes that utility-scale CAES facilities in Maryland are not reasonably foreseeable.

VI. DISCUSSION

A. Purpose and Need

The purpose of the proposed project (licensing of Calvert Cliffs 3) is to produce baseload power within the region of interest.[45] Where, as here, the federal agency is not the sponsor of a project, the NRC may accord substantial weight to an applicant's goals for the proposed project, which delimit the universe of reasonable alternatives.[46] Here, the proposed Calvert Cliffs 3 aims to produce approximately 1600 MW(e) of baseload power in Maryland, which is the region of interest, later this decade. The NRC and the State of Maryland both reviewed the proposed Calvert Cliffs 3 and concluded that there is a need for at least that amount of baseload power in Maryland. Thus, the NRC need only evaluate energy generation alternatives that are reasonable options for producing baseload power in Maryland.

B. Energy Alternatives

As discussed in the testimony of Mr. Lutchenkov, the FEIS correctly notes that the three primary energy sources for generating baseload electric power in the United States are coal, natural gas, and nuclear energy.[47] Each of these energy sources is technologically proven and capable of generating the needed baseload power in the region of interest.[48] As a result,

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45 Contention 10C does not challenge UniStar's purpose and need. Thus, the objective of Calvert Cliffs 3 — production of baseload power — is not within the scope of the admitted contention. Similarly, the use of Maryland as the region of interest is also not within the scope of Contention 10C.

46 *Citizens Against Burlington, Inc. v. Busey*, 938 F.2d 190, 197-198 (D.C. Cir. 1991); see also FEIS at 8-1 (Exh. NRC00003A).

47 UniStar Testimony at ¶20. Baseload power plants are intended to meet a region's continuous energy demand and typically produce energy at a constant rate. Baseload plants typically run continuously except during repairs or scheduled maintenance.

48 *Id.*

these energy alternatives were carried forward in the NRC's analysis of energy sources.[49] The NRC also considered a "combination of energy alternatives." This combination included 1200 MW(e) of natural gas combined-cycle generating units at the Calvert Cliffs site; 25 MW(e) from hydropower; 75 MW(e) from solar power; 100 MW(e) from biomass sources, including municipal solid waste; 100 MW(e) from conservation and demand-side management programs (beyond currently plans); and 100 MW(e) from wind power.[50] The wind and solar power would need to be coupled with a storage mechanism such as compressed air energy storage ("CAES") to provide baseload power.[51]

The FEIS also considered a number of other discrete generation sources to assess whether they were capable of providing the needed baseload power. Specifically, the NRC considered oil-fired generation, wind power, solar power, hydropower, geothermal energy, wood waste, municipal solid waste, other bio-mass derived fuels, and fuel cells.[52] The NRC Staff determined that none of these discrete generation sources were, on their own, a reasonable alternative to construction of a baseload plant within the region of interest for a variety of reasons.[53]

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49 The evaluations of the environmental impacts of these discrete energy sources are summarized in the FEIS at 9-30 (Exh. NRC00003A) and are also discussed in the UniStar Testimony at ¶¶22, 70, 75.

50 FEIS at 9-28.

51 *Id*.

52 *Id*. at 9-20 to 9-27.

53 *Id*.

C. Wind Power

In Contention 10C the Intervenors assert that, while the NRC Staff assumes a contribution from all wind power sources of only 100 MW(e) in the combination alternative, the proposed Bluewater Wind project alone would provide 600 MW of power.[54] In addition, Intervenors maintain that more power will be produced off the nearby coasts of Delaware and New Jersey, also feeding into the same PJM grid.[55] Intervenors also cited the Department of Energy's assessment of offshore wind potential in Maryland to support their argument that the NRC Staff underestimated Maryland's offshore wind power potential. Thus, according to Intervenors, the FEIS significantly underestimated the potential contribution of wind power to the combined alternative as a source of baseload power. But, as discussed below, the NRC Staff has not underestimated the potential contribution of wind power in the FEIS. The contribution of wind power to the combination of alternatives in the FEIS is reasonable.

The testimony of Mr. Stefano Ratti addresses in detail the potential contribution of wind power to the combination of energy alternatives. Mr. Ratti provides background information on the current state of wind power technologies, both onshore and offshore.[56] Mr. Ratti explains that capacity factors for onshore wind installations range from 15% to 45%, with most of the installations between 25% and 35%.[57] For offshore wind installations in the mid-Atlantic region, capacity factors are expected to be around 35-40%.[58] Mr. Ratti also discusses

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54 Contention 10 at 9.

55 *Id.*

56 UniStar Testimony at ¶23.

57 *Id.* at ¶24.

58 *Id.*

the permitting process for onshore and offshore wind projects and highlights the very long permitting process, particularly for offshore projects.[59]

Mr. Ratti provides information regarding the status of wind power projects in Maryland and in the Mid-Atlantic region.[60] Mr. Ratti identifies the two existing large-scale onshore projects highlighted in the FEIS and identifies a few other onshore projects that are under development in Maryland and the nearby area. Mr. Ratti also discusses the status of various offshore wind projects in the mid-Atlantic.[61] He first notes that no offshore wind projects are currently operational in Maryland or the mid-Atlantic region.[62] He explains that the proposed Bluewater project in Delaware is the most advanced offshore project, but concludes that the project is unlikely to be put into service for some time owing to permitting challenges and unfavorable economics.[63] Mr. Ratti testifies that Bluewater's other projects, including an offshore project in Maryland, are less advanced and unlikely to be completed in the foreseeable future.[64]

After identifying the current and planned wind projects (onshore and offshore), Mr. Ratti explains his conclusions regarding the projected installed capacities for wind power used in the FEIS. Mr. Ratti explains that, in his professional opinion, wind power capacity will be added only to the extent that it is used to fulfill Maryland's Renewable Portfolio Standard

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59 *Id.* at ¶28.

60 *Id.* at ¶¶32-38.

61 *Id.* at ¶¶34-36.

62 *Id.* at ¶35.

63 *Id.* at ¶¶36-37.

64 *Id.* at ¶37.

("RPS") requirements and is the lowest-cost renewable option. Mr. Ratti's conclusions are consistent with the reference case in the Long Term Electricity Report ("LTER") for Maryland.[65] The LTER reference case is based on the current regulatory environment and Maryland's RPS. The LTER reference case shows 190 MW of additional wind capacity coming on line;[66] however, this includes the Criterion and Roth Rock projects, which are already operating. As a result, Mr. Ratti only expects an additional 70 MW of installed wind capacity, or 21 MW(e) on average, over the next several years. This is far below the 100 MW(e) used by the NRC Staff in the FEIS.[67]

Mr. Ratti also discusses a "sensitivity analysis" on installed wind capacity. He testifies that, in the unlikely event that all of the new renewable energy necessary to satisfy the RPS were to come from wind power, this would represent approximately an additional 570 MW of wind power, or 170 MW(e) on average. While this is somewhat greater than the amount considered in the FEIS combination of alternatives, this unlikely scenario involves less generation than the bounding scenario considered by the NRC in the FEIS.[68] Beyond the RPS requirements, Mr. Ratti testifies that he does not expect additional wind capacity to come on line.

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65 *Id.* at ¶34.

66 190 MW of installed capacity equates to 57 MW(e). The "MW(e)" values presented here and elsewhere in the testimony for wind projects are average values based on a capacity factor of 30%.

67 UniStar Testimony at ¶37.

68 FEIS at 9-28, 9-30 (Exh. NRC00003A).

Thus, on balance and in Mr. Ratti's professional opinion, the best estimate for projected installed wind capacity is 21 MW(e). However, in his view, the use of 100 MW(e) in the FEIS combination of alternatives is also reasonable.[69]

D. Solar Power

In Contention 10C the Intervenors assert that, while the NRC Staff assumes a contribution from all solar power sources of only 75 MW(e), the DEIS failed to quantify the possible contribution solar photovoltaic ("PV") could make for Maryland.[70] The Intervenors also argue that the FEIS continues to give short shrift to solar power, with little to no justification for the inclusion of only 75 MW(e) of solar power in its combination of alternatives.[71] The Intervenors cite two projects in Maryland (with a total of 4.9 MW of installed capacity) to support the proposition that the contribution of solar will grow rapidly.[72] Thus, according to Intervenors, the FEIS significantly underestimated the potential contribution of solar power to the combined alternative as a source of baseload power. But, as discussed below, the NRC Staff has not underestimated the potential contribution of solar power in the FEIS. The contribution of solar power to the combination of alternatives in the FEIS is reasonable.

The testimony of Mr. Stefano Ratti addresses in detail the potential contribution of solar power to the combination of energy alternatives. Mr. Ratti provides background information on the current state of solar power technologies.[73] Mr. Ratti explains that capacity

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69 UniStar Testimony at ¶38.

70 Contention 10 at 10.

71 Amended Contention 10C at 10.

72 *Id.*

73 UniStar Testimony at ¶39.

factors are relatively low for solar PV because solar PV generates electricity only when the sun is shining. He notes that fixed tilt (at latitude) capacity factors are typically around 14-18% for the eastern United States.[74] Tracking systems can increase the capacity factor, but add to the cost. He explains that an assumed solar capacity factor of 15% is reasonable for Maryland. Mr. Ratti notes that utility-scale solar plants use a significant amount of land, typically between 2.5 and 12.4 acres of land per MW installed.[75] He also explains that smaller solar projects, up to several hundred KW, can often be located on rooftops, which reduces land use impacts.

Mr. Ratti provides an overview of existing and planned utility-scale solar projects in Maryland and discusses various programs in place to promote solar power.[76] Regarding the solar potential in Maryland, Mr. Ratti notes that the raw potential for solar is significant.[77] He goes on to testify, however, that solar is not economically competitive with other power sources. As a result, solar deployment is limited to government mandates and by the availability of incentives.[78] Mr. Ratti concludes that, even considering further dramatic reductions in cost, solar PV still will not be competitive with conventional power sources.[79] Therefore, Mr. Ratti concludes that the amount of solar power that is likely to come on line in Maryland is effectively capped by the solar carve-out in the RPS (2% by 2022).[80]

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74 *Id.* at ¶40, citing Department of Energy*,* National Renewable Energy Laboratory, *2008 Solar Technologies Market Report*, January 2010 (Exh. APL000039).

75 *Id.* at ¶41.

76 *Id.* at ¶¶44-49.

77 *Id.* at ¶44.

78 *Id.*

79 *Id.*

80 *Id.*

Mr. Ratti explains that the LTER for Maryland estimates that future installed capacity of solar power is closely linked to the levels required in the solar RPS carve-out (2% by 2022).[81] In terms of installed capacity, the LTER reference case predicts that there will be 498 MW of new solar capacity installed in Maryland over the next 10 years, equivalent to approximately 75 MW(e) on average.[82] Mr. Ratti's expectations are generally in line with the LTER reference case scenario.[83] This is also consistent with the NRC Staff's use of 75 MW(e) in the combination of alternatives considered in the FEIS.[84]

On balance, Mr. Ratti concludes that the 75 MW(e) used in the FEIS combination of energy alternatives is reasonable.[85] He further concludes that significantly greater amounts of installed solar capacity are highly unlikely.[86]

E. <u>Energy Storage</u>

The purpose and need for the proposed Calvert Cliffs 3 is to produce baseload power. For a large solar or wind facility to be practical as a means of providing baseload power, a mechanism to store large quantities of energy is needed. Possible energy storage mechanisms include pumped hydroelectric or CAES. The Energy Information Administration ("EIA") is not

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81 *Id.* at ¶48.

82 *Id.*

83 *Id.*

84 As with wind, Mr. Ratti also included a "sensitivity" analysis. In terms of installed capacity, the unlikely LTER high renewables scenario forecasts that there will be 785 MW of additional solar capacity by 2020 (approximately 120 MW(e)), 1068 MW by 2022 (160 MW(e)), and 1158 MW by 2030 (174 MW(e)). *Id.* Even the highest of these projections would not change the conclusions in the FEIS. *Id.* at ¶71.

85 *Id.* ¶51.

86 *Id.*

projecting any growth in pumped storage capacity through 2030.[87] In addition, the potential for new hydroelectric development in Maryland is limited.[88] So, these technologies were not considered further in the FEIS.[89] The other primary energy storage mechanism is CAES. CAES is discussed in detail in the testimony of Septimus van der Linden.

Mr. van der Linden first provides an overview of CAES plants. He explains that a CAES plant uses low-cost, off-peak electricity to compress air into a storage medium.[90] During high electricity demand periods, the stored energy is recovered by releasing the compressed air through a combustion turbine to generate electricity.[91] Mr. van der Linden highlights the various types of storage that are used for CAES and discusses the key factors involved in selecting suitable CAES storage media. Mr. van der Linden testifies that the most common type of CAES plant involves salt caverns, which are often solution-mined.[92] Natural reservoirs, such as aquifers, depleted gas fields, or hard rock caverns, also could be used for CAES.[93] Pipe storage is capable of being used for smaller CAES facilities, though with significant limitations that generally preclude use for bulk energy storage (*i.e.*, to provide generation that approximates baseload).[94] Mr. van der Linden then describes the two operating utility-scale CAES facilities in

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87 FEIS at 9-21.

88 *Id*.

89 *Id*.

90 UniStar Testimony at ¶52.

91 *Id*.

92 *Id*. at ¶54.

93 *Id*. at ¶¶60-61.

94 *Id*. at ¶62.

detail and discusses other CAES projects that are planned or under consideration in the United States.[95]

Regarding CAES in Maryland, Mr. van der Linden explains that there are no known salt domes or strata salt deposits in Maryland, no natural reservoir storage sites under consideration for CAES in Maryland, and no pipe-storage systems under development in Maryland.[96] He also explains that development of utility-scale CAES plants in Maryland, even assuming suitable geologic structures are available, would be a lengthy process.[97] Given the length of time needed to permit CAES facilities and based on his experience with CAES projects, Mr. van der Linden concludes that CAES facilities on the scale needed to support the wind and solar generation assumed in the FEIS combination of alternatives are not reasonably foreseeable.[98]

In Amended Contention 10C, the Intervenors specifically mentioned two CAES technologies under development.[99] Mr. van der Linden evaluates those technologies, including the path to commercialization.[100] He concludes that commercialization of either technology, after satisfactory demonstration of proof of concept and scale up economics, is still many years away.[101] He notes that the primary limitations on the use of these technologies in bulk energy

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95 *Id*. at ¶¶56-57.

96 *Id*. at ¶¶60-62.

97 *Id*. at ¶65.

98 *Id*. at ¶¶66-69.

99 Amended Contention 10C at 9-10.

100 UniStar Testimony at ¶63.

101 *Id*.

storage systems are time of storage (*e.g.*, limited to a few hours) and the overall storage requirements needed for large MW facilities (*i.e.*, number of small individual units).[102] Thus, he concludes that neither of these technologies is likely to be available to support the wind or solar generation assumed in the FEIS combination of energy alternatives.[103]

Mr. van der Linden explains that it would be theoretically possible to generate the equivalent of 100 MW(e) of "baseload" by using wind, in conjunction with CAES, or 75 MW(e) of "baseload" by using solar, in conjunction with CAES.[104] But, Mr. van der Linden concludes that, given the current state of CAES development in Maryland, this is highly unlikely to occur in the next decade or longer.[105] Overall, Mr. van der Linden concludes that a CAES facility, in conjunction with wind or solar power, is not likely to support significant amounts of "baseload" power from renewables (100 MW(e) for wind, 75 MW(e) for solar) in the region of interest for the next decade or two.[106]

F. Evaluation of Energy Alternatives

1. Combination of Energy Alternatives

The specific combination of energy alternatives evaluated in the FEIS consists of the following: 1200 MW(e) of natural gas combined-cycle generating units at the Calvert Cliffs site; 25 MW(e) from hydropower; 75 MW(e) from solar power; 100 MW(e) from biomass

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102 *Id.*

103 *Id.*

104 *Id.* at ¶¶68-69.

105 *Id.* Mr. van der Linden also evaluated the "sensitivity analysis" in the FEIS (*i.e.*, quadrupling installed wind capacity). He concludes that a 400 MW CAES facility is not reasonably foreseeable, even assuming that suitable geological structures to support CAES could be identified and developed in Maryland.

106 *Id.*

sources, including municipal solid waste; 100 MW(e) from conservation and demand-side management programs (beyond current plans); and 100 MW(e) from wind power.[107] The wind and solar power would need to be coupled with a storage mechanism such as CAES to provide baseload power.[108] This combination of alternatives considered in the FEIS is not environmentally preferable to Calvert Cliffs 3.[109]

In selecting 100 MW(e) as the contribution from wind power, in conjunction with CAES, in the combination of alternatives, the FEIS explains that the NRC considered a range of values before selecting the reasonable alternative.[110] Ultimately, the FEIS included 100 MW(e) contribution from a combination of wind and CAES even though generation with storage of this magnitude is not currently proposed, approved, or under construction in Maryland.[111] Although Mr. Ratti projects actual installation of wind capacity to be less than 100 MW(e), he testifies that 100 MW(e) of wind power is a reasonable assumption.[112] Mr. van der Linden, however, testifies that a 100 MW CAES facility, in conjunction with wind power, is not reasonably foreseeable in the region of interest given the lack of known suitable storage.[113] The NRC Staff analysis in the FEIS, with respect to the wind component of the combination alternative, is overly optimistic regarding the availability of wind-supported baseload power.

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107 FEIS at 9-28 (Exh. NRC00003A).

108 *Id.*

109 FEIS at 9-30.

110 *Id.* at 9-28.

111 *Id.*

112 UniStar Testimony at ¶21.

113 *Id.* at ¶68.

The FEIS also includes information regarding the selection of a 75 MW(e) contribution from solar power in the combination of alternatives.[114] The solar power would also need to be coupled with a storage mechanism, such as CAES, to provide baseload power. The FEIS included a 75 MW(e) contribution even though generation with storage of this magnitude is not currently proposed, approved, or under construction in Maryland.[115] Mr. Ratti testifies that 75 MW(e) of solar capacity is reasonably realistic based on the solar carve-out in the Maryland RPS (2% by 2022).[116] However, Mr. Ratti also concludes that the amount of solar power that is likely to come on line in Maryland is effectively capped the solar carve-out in the RPS.[117] Thus, he concludes that generation of more than 75 MW(e) is unlikely, even considering further dramatic reductions in the cost of solar power.[118] Mr. van der Linden, however, testifies that a 75 MW CAES facility, in conjunction with solar power, is not reasonably foreseeable in the region of interest given the lack of known suitable storage.[119] Thus, the NRC Staff analysis in the FEIS, with respect to solar component of the combination alternative, is overly optimistic regarding the availability of solar-supported baseload power.

Given that significant production of wind or solar, in conjunction with CAES, beyond that considered in the FEIS combination alternative is unlikely, any reasonable combination of energy alternatives will necessarily include a significant contribution of power

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114 FEIS at 9-28.

115 *Id.*

116 UniStar Testimony at ¶48.

117 *Id.* at ¶44.

118 *Id.* at ¶48.

119 *Id.* at ¶69.

produced by natural gas.[120] The Intervenors acknowledged as much in Contention 10, recognizing that, even with a greater contribution of wind and solar power, the combined alternative would still include natural gas combined-cycle generating units as a back-up power source when the alternative sources are not able to generate the required amount of baseload power.[121]

2. Comparison of Energy Alternatives

In light of the environmental impacts associated with the proposed action and the use of natural gas, no reasonable combination of alternatives will be environmentally preferable to the proposed action.[122] Because the impacts of any combination of energy alternatives will be greater than the impacts of the natural gas alternative (even accounting for the proportional decrease in impacts, including air emissions, associated with a smaller natural gas facility relative to a 1600 MW(e) gas plant), there will be no combination of alternatives that is environmentally preferable to natural gas.[123] As a result, there will be no combination of

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120 Coal could also provide the baseload power needed in the combination of alternatives. However, relative to a coal-fired plant, a natural gas-fired plant would have similar types of emissions, but in lower quantities. FEIS at 9-14. Using natural gas in the combination of alternatives therefore yields conservative results (*i.e.*, reduced impacts) when compared to other baseload energy alternatives.

121 Contention 10 at 10.

122 Joint Intervenors have not contested the significance level of the environmental impacts of Calvert Cliffs 3 as described in the FEIS. Nor have the Joint Intervenors contested the significance level of the environmental impacts of using natural gas or using wind and solar in conjunction with CAES to provide baseload power. The environmental impacts associated with the discrete power sources are therefore not within the scope of the admitted contention.

123 FEIS at 9-30 to 9-31; *see also Exelon Generation Company* (Early Site Permit for the Clinton ESP Site), LBP-05-19, 62 NRC 134, 165-166 (2005) (recognizing the use of conservative assumptions when evaluating the environmental impacts of a combination of alternatives).

alternatives that is environmentally preferable to nuclear generation.[124] In short, in all cases the combination alternative is not environmentally preferable to construction of a new baseload nuclear power generating plant located in the region of interest.[125] Any dispute over the specific, relative mix of wind or solar used in the combination of alternatives is not one that would affect the outcome of the NEPA analysis and therefore is not a material issue in this proceeding.[126]

3. Sensitivity Analysis

The conclusion that a combination of alternatives is not environmentally preferable to a new nuclear unit is not sensitive to even large changes in the contribution of wind and solar relative to natural gas in the combination of alternatives. For example, the FEIS also considered the result if wind generation coupled with storage was far greater than assumed in the baseline combination alternative. If the wind contribution was hypothetically quadrupled to 400 MW(e) of baseload power — equivalent to an installed capacity of at least 1000 to 1200 MW(e) — in conjunction with a 400 MW(e) CAES plant, the combination of alternatives would still require a 900 MW(e) contribution from natural gas.[127] While this would proportionally decrease the air emissions associated with the natural gas component of the combination of energy alternatives, it would not change the overall impact categorizations.[128] Under this scenario, the impact categorizations in FEIS Table 9-3 would not change, except that impacts to land use and

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124 UniStar Testimony at ¶¶22, 70, 75; *see also* FEIS at 9-30 to 9-31.

125 UniStar Testimony at ¶75.

126 *See, e.g.*, *Luminant Generation Company, LLC* (Comanche Peak Nuclear Power Plant, Units 3 and 4), LBP-11-04, __ NRC __, __ (slip op. at 29) (Feb. 24, 2011) (finding that a dispute over the details of transmission congestion in the NEPA review were immaterial because resolution would not change the outcome of the proceeding).

127 FEIS at 9-28.

128 *Id.* at 9-28.

ecology might become LARGE if onshore wind energy is used.[129] If offshore wind is used, increased impacts to aquatic ecology are likely. In any event, the environmental impacts of this scenario are still greater than the impacts of the proposed action.[130] Thus, even a scenario involving a 400 MW(e) contribution from wind is not environmentally preferable to the proposed action.[131]

Similarly, even if solar contribution (with storage) was hypothetically quadrupled to 300 MW(e) of baseload power, the combination alternative would still require 1000 MW(e) from natural gas.[132] While this would proportionally decrease the air emissions associated with the natural gas component of the combination of energy alternatives, it would not change the overall impact categorizations.[133] Using the FEIS methodology, with a fourfold increase in the contribution of solar, the impact categorizations would not change except that land use impacts could increase from MODERATE to MODERATE to LARGE, due to the low energy density of solar radiation relative to other common energy sources.[134] Even if photovoltaics could be deployed on rooftops and sufficient storage mechanisms were available in conjunction with the photovoltaics to produce baseload power, the environmental impacts of the combination of alternatives still would not change appreciably. Given the environmental impacts associated with significantly increasing solar production to 300 MW(e), a combination of alternatives that

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129 *Id.* at 9-30; UniStar Testimony at ¶71.

130 *Id.* at 9-28 and 9-30; UniStar Testimony at ¶71.

131 UniStar Testimony at ¶71.

132 *Id.*

133 *Id.*

134 *Id.*

includes a significant increase in solar production, in conjunction with energy storage, is not clearly preferable to construction of a new baseload nuclear power generating plant located within UniStar's region of interest.

Importantly, the two sensitivity analyses (more wind, more solar) presume that a much larger contribution of wind or solar power, within a combination of alternatives providing baseload power, is reasonable. Based on the record, this is not the case. First, the NRC Staff explained in the FEIS that offshore wind capacity postulated in the sensitivity analysis exceeds <u>by a factor of five or more</u> the amount of offshore wind projected by the Department of Energy's Energy Information Administration ("DOE/EIA") for the entire United States by the year 2030.[135] Based on what is known about the limited proposals for onshore and offshore wind in Maryland, the wind sensitivity scenario could not be implemented in time to meet the need for power.[136] Moreover, utility-scale solar thermal or solar photovoltaic power in the mid-Atlantic region is not projected through the year 2035.[137] And, the amount of installed solar PV capacity is effectively capped by the 2% solar carve-out in the Maryland RPS.[138] Thus, a combination of alternatives that involves significantly greater installed capacities of wind or solar than that assumed in the FEIS combination of alternatives is not reasonably foreseeable.

Moreover, production of baseload power using wind or solar technology, in conjunction with energy storage (*e.g.*, CAES), is neither proven nor available in the region.[139]

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135 FEIS at 9-30.

136 UniStar Testimony at ¶37.

137 FEIS at 9-24.

138 UniStar Testimony at ¶44.

139 *Id*. at ¶¶66-69.

As noted above, there are no known large-scale candidate storage facilities for CAES in Maryland.[140] Thus, even if sufficient wind or solar resources could be installed in time to serve the need for power, a suitably-sized CAES plant could not reasonable be commissioned in time to support "baseload" renewable generation.[141]

On balance, neither of the sensitivity scenarios (more wind or more solar) is reasonable. Based on the record, both scenarios are remote and speculative, at best. Therefore, they need not be considered further.

G. <u>Compliance with Part 51 and NEPA</u>

By considering a range of alternatives, including a number of different combinations of energy alternatives, the NRC Staff has met its obligation under NEPA as a matter of law. NEPA does not require an applicant to look at every conceivable alternative, but rather requires only consideration of feasible, non-speculative, reasonable alternatives. And, NEPA does not require the NRC to choose the environmentally preferred alternative.[142] Here, the NRC Staff has "come to grips with all important considerations," including the current status of wind and solar projects in Maryland, CAES technologies and availability to support use of renewable as baseload sources, and the environmental impacts of the alternate energy generation

140 *Id*. at ¶¶60-62.

141 *Id*. at ¶68.

142 In Contention 10C, the Intervenors argue that a combination of alternatives involving a greater contribution from wind or solar power could "quite likely" produce baseload power "at reduced economic cost." Contention 10 at 10. Cost issues are relevant to a comparison of alternatives only if an environmentally preferable alternative is identified. *S.C. Elec. & Gas Co.* (Virgil C. Summer Nuclear Station, Units 2 & 3), CLI-10-1, 71 NRC __, slip op. at 30-31 (Jan. 7, 2010) *citing Consumers Power Co.* (Midland Plant, Units 1 & 2), ALAB-458, 7 NRC 155, 162 (1978). As a result, issues concerning the costs of wind or solar power relative to nuclear are not material.

sources, including natural gas.[143] In the FEIS, the NRC Staff assumed a reasonable and realistic combination of alternatives — including wind and solar, in conjunction with energy storage, and natural gas — based on evaluations of technologically and economically achievable generation technologies in the region of interest. As discussed in the testimony, no reasonably foreseeable combination of alternatives is environmentally preferable to the proposed action — even accounting for some uncertainty in the amount of baseload energy that could be produced using wind or solar, in conjunction with energy storage, and natural gas.

VII. CONCLUSIONS

For the reasons set forth in this Initial Statement of Position, as supported by the accompanying testimony and evidence, the NRC Staff has taken the requisite "hard look" at reasonable energy alternatives, including a combination of alternatives with significant contributions from wind or solar power, in conjunction with energy storage, and natural gas. The NRC Staff considered the potential for wind and solar power, in conjunction with energy storage, and natural gas to provide baseload power. The specific combination of energy alternatives selected by the NRC Staff is reasonable and realistic. The NRC Staff's evaluation of the environmental impacts of a combination of energy alternatives demonstrates that no reasonable combination of alternatives is environmentally preferable to the proposed action — even accounting for some uncertainty in the amount of baseload energy that could be produced using wind or solar, in conjunction with energy storage. As a result, the FEIS satisfies Part 51 and NEPA. The Licensing Board should resolve Contention 10C in favor of UniStar and the NRC Staff.

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143 *Exelon Generation Co., LLC* (Early Site Permit for Clinton ESP Site), CLI-05-29, 62 NRC 801, 811 (2005).

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	
	)	
CALVERT CLIFFS 3 NUCLEAR PROJECT, LLC AND UNISTAR NUCLEAR OPERATING SERVICES, LLC	)	Docket No. 52-016
	)	
(Calvert Cliffs Nuclear Power Plant, Unit 3)	)	

CERTIFICATE OF SERVICE

I hereby certify that copies of "UNISTAR INITIAL STATEMENT OF POSITION ON CONTENTION 10C" have been served upon the following persons via the Electronic Information Exchange ("EIE") this 21st day of October 2011, which to the best of my knowledge resulted in transmittal of the foregoing to those on the EIE Service List for the captioned proceeding.

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APL000001
10/21/2011

October 21, 2011

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of:	)	
	)	
CALVERT CLIFFS 3 NUCLEAR PROJECT, LLC AND UNISTAR NUCLEAR OPERATING SERVICES, LLC	)	Docket No. 52-016-COL
	)	
(Calvert Cliffs Nuclear Power Plant, Unit 3)	)	

DIRECT TESTIMONY OF UNISTAR WITNESSES DIMITRI LUTCHENKOV, STEFANO RATTI, AND SEPTIMUS VAN DER LINDEN

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

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DIRECT TESTIMONY OF UNISTAR WITNESSES DIMITRI LUTCHENKOV, STEFANO RATTI, AND SEPTIMUS VAN DER LINDEN

I. INTRODUCTION

A. Dimitri Lutchenkov

Q1. Please state your full name.

A1. My name is Dimitri Lutchenkov ("DL").

Q2. By whom are you employed and what is your position?

A2. I am currently employed as the Director, Environmental Affairs and Special Projects, for UniStar Nuclear Energy, LLC ("UniStar"). In my position at UniStar I have responsibility for the environmental aspects of the Calvert Cliffs 3 licensing reviews, including preparation of the Environmental Report ("ER") and development of responses to NRC Staff Requests for Additional Information ("RAIs").

Q3. Please summarize your educational and professional qualifications.

A3. My professional and educational qualifications are summarized in the curriculum vitae attached to my declaration (Exh. APL000002). Briefly summarized, I earned a B.S. in mechanical engineering from the University of Maryland. I have over 30 years experience in developing energy projects. Since 2008, I have been employed as Director of Environmental Affairs at UniStar. Prior to that, I was employed as Project Director at Constellation Energy.

Q4. What is the purpose of your testimony?

A4. The purpose of my testimony is to provide my opinion on Contention 10C in this matter concerning the Calvert Cliffs 3 project, including the purpose and need for the new unit and the environmental impacts of alternatives. I also describe and evaluate the analysis performed by the NRC Staff in the FEIS related to the contention. In addition, I provide background information on the Calvert Cliffs 3 application and licensing reviews.

Q5. What documents or information have you reviewed to prepare your testimony?

A5. I have reviewed the discussion of energy alternatives in Section 9.3 of the DEIS and FEIS (Exhs. APL000050 and NRC00003A), including the NRC Staff's analysis of the potential for wind, solar, and a combination of energy alternatives to provide the 1600 MW(e) of baseload power that would meet UniStar's stated project purpose and need. I have also reviewed the filings and decisions in this proceeding that relate to Contention 10C.

B. Stefano Ratti

Q6. Please state your full name.

A6. My name is Stefano Ratti ("SR").

Q7. By whom are you employed and what is your position?

A7. (SR) I am the founder and owner of Chaberton Consulting.

Q8. Please summarize your educational and professional qualifications.

A8. (SR) My professional and educational qualifications are summarized in the curriculum vitae attached to my declaration (Exh. APL000003). Briefly summarized, I earned a degree in Energy Systems Engineering from Polytechnic University of Milan and a M.S. in Mechanical Engineering from the University of Illinois at Chicago. Prior to starting Chaberton Consulting, I was Vice President, Renewable Energy Business Group, at AREVA. While at AREVA, I was responsible for developing strategic renewable initiatives, including evaluation of potential acquisitions in the renewable energy sector and creation of renewable energy businesses in the United States.

Q9. What is the purpose of your testimony?

A9. (SR) The purpose of my testimony is to provide an assessment of the current state of wind and solar technologies in the United States. I provide an assessment of the key parameters involved in deployment of wind and solar with a focus on wind and solar projects in Maryland. I also evaluate the NRC's analysis of the combination of energy alternatives in the FEIS as they relate to wind and solar power.

Q10. What documents or information have you reviewed to prepare your testimony?

A10. (SR) I have reviewed the NRC Staff's Draft and Final Environmental Impact Statements for Calvert Cliffs 3 (Exhs. APL000050 and NRC00003A). I have also reviewed the filings and decisions in this proceeding that relate to Contention 10C. In addition, I have reviewed documents regarding the status of existing and planned wind and solar projects in Maryland and the region.

C. Septimus van der Linden

Q11. Please state your full name.

A11. My name is Septimus van der Linden ("SVDL")

Q12. By whom are you employed and what is your position?

A12. (SVDL) I am the founder, co-owner, and President of BRULIN Associates LLC.

Q13. Please summarize your educational and professional qualifications.

A13. (SVDL) My professional and educational qualifications are summarized in the curriculum vitae attached to my declaration (Exh. APL000004). During my previous employment with Curtiss/Wright Power Systems (13 years) and then with Alstom (19 years), I investigated compressed air energy storage systems ("CAES"). I worked for Brown Boveri Corporation (BBC) – Asea Brown Boveri ("ABB"), which built the first CAES plant in Huntorf, Germany, in 1976. BBC also developed a machinery product range for the U.S. market. I was tasked at BBC to support that effort with the Electric Power Research Institute ("EPRI"), utilities, and Architect/Engineers. I have been involved in the design and application aspects of CAES plant and technology in the U.S. and participated in many EPRI-lead workshops that led to construction of the first CAES plant in the U.S. at McIntosh, Alabama. I currently consult on CAES-related issues.

Q14. What is the purpose of your testimony?

A14. (SVDL) The purpose of my testimony is to provide an overview of CAES, including background information on CAES, the status of existing and planned CAES plants, and developments in CAES technology. I provide an assessment of the use of wind and solar, in conjunction with CAES, to provide baseload power in Maryland. I also evaluate the NRC's analysis of the combination of energy alternatives in the FEIS as they relate to energy storage.

Q15. What documents or information have you reviewed to prepare your testimony?

A15. (SVDL) I have reviewed the NRC Staff's Draft and Final Environmental Impact Statements for Calvert Cliffs 3 (Exhs. APL000050 and NRC00003A). I have also reviewed the filings and decisions in this proceeding that relate to Contention 10C. In addition, I reviewed documents regarding the status of existing and planned CAES projects in the United States.

II. DISCUSSION

A. Need for Baseload Power

Q16. What is baseload power?

A16. (DL) Baseload power plants are intended to meet a region's continuous energy demand and typically produce energy at a constant rate. Baseload plants typically run continuously except during repairs or scheduled maintenance. Coal and nuclear power plants typically operate in a baseload manner. Natural gas combined-cycle generation plants may be used for baseload generation, but are often used as intermediate generation sources. Wind energy and solar energy are both considered intermittent energy sources, meaning that these sources may be uncontrollably variable or more intermittent in normal operational conditions compared to traditional baseload plants.

Q17. What is the region of interest?

A17. (DL) The region of interest is the State of Maryland.

Q18. What is the purpose and need for the proposed action?

A18. (DL) The purpose and need for the proposed NRC action (issuance of a combined license for Calvert Cliffs 3) is to provide for additional large baseload electrical generating capacity within the State of Maryland. Calvert Cliffs 3 will provide approximately 1600 MW(e) of baseload power in the region of interest. In 2009, the Maryland Public Service Commission ("MPSC") issued a Certificate of Public Convenience and Necessity ("CPCN") for a new nuclear unit at Calvert Cliffs. In issuing the CPCN, the MPSC took into account the effect of the proposed new unit on the stability and reliability of the electrical system. Subsequently, the MPSC issued a 2010 report showing a decrease in peak demand and utility forecasted energy sales in Maryland compared to its previous year's report, but continued to assert that there will still be a need for central power stations in Maryland.[1]

B. Energy Alternatives

Q19. Does NEPA require consideration of alternatives?

A19. (DL) Yes. However, NEPA does not require an applicant to look at every conceivable alternative. Rather, NEPA requires only consideration of feasible, non-speculative, reasonable alternatives.[2] According to NUREG-1555, Section 9.2.2, if the proposed project is intended to supply baseload power, a competitive alternative would also need to be capable of supplying baseload power. There are many possible combinations of energy alternatives that could satisfy a need for baseload power.

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[1] FEIS at 1-9.

[2] *See, e.g.*, NUREG-1555, Section 9.2.2 (Exh. NRC000008).

Q20. What energy alternatives did the NRC Staff consider in the FEIS?

A20. (DL) The FEIS considers the environmental impacts of discrete power generation sources, a combination of sources, and those power generation technologies that are technically reasonable and commercially viable for producing baseload power. FEIS at 9-7 (Exh. NRC00003A). The FEIS correctly notes that the three primary energy sources for generating baseload electric power in the United States are coal, natural gas, and nuclear energy. The FEIS considers the environmental impacts of those discrete power generation sources, as well as a combination of energy alternatives. The NRC Staff concludes in Section 9.2.3 of this FEIS that renewable energy alternatives, such as wind and solar, would not by themselves be reasonable alternatives to a new nuclear generating unit operated as a baseload power plant.

Q21. Do you agree with the NRC Staff's conclusions in the FEIS regarding the reasonable energy alternatives?

A21. (DL) Yes. I agree that coal and natural gas are reasonable alternatives to the proposed action (nuclear). And, I agree that coal and natural gas are not environmentally preferable to Calvert Cliffs 3.

The FEIS also considered a combination of energy alternatives consisting of the following: 1200 MW(e) of natural gas combined-cycle generating units at the Calvert Cliffs site; 25 MW(e) from hydropower; 75 MW(e) from solar power; 100 MW(e) from biomass sources, including municipal solid waste; 100 MW(e) from conservation and demand-side management programs (beyond current plans); and 100 MW(e) from wind power.[3] In light of the project goal of producing baseload

[3] FEIS at 9-28 (Exh. NRC00003A).

power, I agree that a fossil energy source, most likely coal or natural gas, will be a significant contributor to any reasonable alternative energy combination. I also agree that this combination of alternatives is reasonable for the purpose of a NEPA discussion. And, as discussed further below, I agree with the NRC Staff conclusions that this combination of alternatives considered in the FEIS is not environmentally preferable to Calvert Cliff 3.

Q22. Briefly summarize the NRC Staff's assessment of the energy alternatives.

A22. (DL) For the natural gas alternative, the FEIS assumes that the plant would use combined-cycle combustion turbines.[4] Overall, the NRC Staff concluded that a 1600-MW(e) natural-gas fired plant would cause LARGE adverse impacts to historic and cultural resources, a SMALL to MODERATE beneficial impact on taxes and economy, SMALL to MODERATE impacts on air quality, and SMALL adverse impacts on land use, water use and quality, ecology, waste management, socioeconomics (except taxes and economy), human health, and environmental justice.[5] I generally agree with this assessment in the FEIS, which is based, in part, on the information presented by UniStar in the ER associated with the Calvert Cliffs 3 COL application.[6]

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4 *Id.* at 9-14.

5 *Id.* at Table 9-4.

6 Calvert Cliffs Power Plant Unit 3 COLA (Environmental Report), Rev. 7 – Chapter 09, Alternatives to the Proposed Action, Sections 9.1 and 9.2, December 20, 2010 (ADAMS Accession No. ML103620413) (Exh. APL000048).

According to the FEIS, the adverse environmental impacts of proposed Calvert Cliffs 3 (*i.e.*, the nuclear generation alternative) upon land use, air quality, water use and quality, waste management, human health, and environmental justice will be SMALL.[7] The NRC Staff concluded that impacts on historic and cultural resources will be LARGE and that the adverse environmental impacts of Unit 3 upon ecology will be MODERATE. The NRC Staff concluded that exposures from liquid pathways, gaseous pathways, or direct radiation from the station operation would be within the limits specified by NRC and EPA regulations.[8] Accordingly, human health impacts and environmental impacts from radiological effluents from Unit 3 would be SMALL.[9] Similarly, the risk-based radiological impacts of accidents at Unit 3 will be SMALL. I generally agree with this assessment in the FEIS, which is based, in part, on the information presented by UniStar in the ER associated with the Calvert Cliffs 3 COL application.

According to the FEIS, the environmental impacts associated with the construction and operation of the combination of energy alternatives are SMALL for water use and quality, human health, and environmental justice. The impacts are SMALL to MODERATE for air quality, waste management, and socioeconomics (except taxes and economy). The environmental impacts are MODERATE for land use and ecology and LARGE for historic and cultural resources. The impacts on

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7 *Id.* at Table 9-4.

8 *Id.* at 5-63 to 5-65 and Tables 5-10 and 5-11.

9 *Id.* at Table 5-20.

socioeconomics (taxes and economy) are SMALL to MODERATE beneficial.[10] The impacts of the combination of energy alternatives accounts for the proportional decrease in impacts, including air emissions, associated with a smaller natural gas facility relative to a 1600 MW(e) gas plant. I generally agree with this assessment in the FEIS, which is based, in part, on the information presented by UniStar in the ER associated with the Calvert Cliffs 3 COL application.

C. Wind Power

Q23. Please provide an overview of wind power technologies, both onshore and offshore.

A23. (SR) Wind power involves the conversion of wind energy into electricity through wind turbines. Most modern turbines are horizontal-axis, three bladed turbines. Wind turbines consist of four main components — rotor, transmission system, generator, and yaw and control systems — which are designed to work together to reliably convert the motion of the wind into electricity. These components are fixed onto or inside the nacelle, which is mounted on the tower. The nacelle rotates (or yaws) according to the wind direction.

Today's wind turbines typically range in size from 1 to 5 MW per turbine, although larger-size turbines are available and 10 MW turbines are under development. Offshore installations tend to be on the higher end of the turbine size spectrum, since there are fewer land-based transportation and construction constraints on the size of the blades, and blades are allowed to rotate faster, since noise is generally less of a concern. In general, there is no theoretical limit to the size of a wind farm, but an

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10 *Id.* at Table 9-3

average onshore wind farm tends to be in the 50-150 MW range. Installations in the Appalachian region tend to be smaller than Great Plains installations, due to topographic constraints and the need to build wind farms on mountain ridges.

Over 90% of installed wind energy worldwide and 100% of domestic wind energy is generated through onshore wind turbines, which offer proven technologies and development processes and a significantly cheaper installed cost than offshore wind installations.

Offshore wind technology has evolved from onshore wind technology. Today, offshore wind technology has been proven for shallow waters (typically, less than 30- or 35-meter deep), with virtually all installations of offshore wind projects in this category. In shallow water, the substructure extends to the sea floor and includes monopoles, gravity bases, and suction buckets. For deeper water, more complicated technologies are necessary, such as jacket substructures and multi-pile foundations, which extend to the sea floor. At some depth, it is no longer economically advantageous to have a rigid structure fixed to the sea floor, and floating platforms may be required. However, these technologies are still in the early development stage and have not been proven at a commercial scale.[11]

Q24. What are the capacity factors for wind projects?

A24. (SR) Capacity factors for wind installations vary greatly depending on location, weather, and climate patterns. Capacity factors for onshore wind installations range

[11] National Renewable Energy Laboratory, "Large-Scale Offshore Wind Power in the United States – Assessment of Opportunities and Barriers," 2010 at 5 ("NREL 2010") (Exh. APL000007).

from 15% to 45%, with most of the installations between 25% and 35%.[12] Capacity factors are typically higher during the night hours, often in the 40%+ range, but then drop during the day (typically during periods of peak load), with daily capacity factors in the range of 25%.[13]

Offshore wind installations benefit from higher-than-average capacity factors, typically higher than 30%, and, in certain cases, as high as 45-50%.[14] For offshore wind installations off of the United States East Coast (New England and Mid-Atlantic), one can expect a capacity factor of around 35-40%.[15]

Q25. How much land does a wind installation require?

A25. (SR) Onshore wind farms are typically built over large areas. Spacing of wind turbines is necessary to minimize turbulence interference between turbines and varies depending on wind patterns and terrains. The distance between wind turbines (between turbine rows and between turbines within a row) is commonly described in terms of rotor diameters. For example, a 3-by-10 spacing means that the turbines are generally spaced 3 rotor diameters apart within rows, and the rows are spaced 10 rotor diameters apart. For a project using wind turbines with a 70-m (230 ft) rotor

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12 Department of Energy, Lawrence Berkley National Laboratory, "2009 Wind Technologies Market Report," 2009 (Exh. APL000008).

13 GE Energy Consulting, "The Effects of Integrating Wind Power on Transmission System Planning, Reliability, and Operations," Prepared for the New York State Energy Research and Development Authority, March 4, 2005 (Exh. APL000009).

14 NREL 2010 (Exh. APL000007).

15 University of Delaware's Center for Carbon-free Power Integration, College of Earth, Ocean, and Environment, "Maryland's Offshore Wind Power Potential," February 1, 2010 (Exh. APL000010).

diameter, this would mean spacing the turbines 210 m (690 ft) apart within a row, and 700 m (2,300 ft) apart between rows.[16] Spacings of 3-by-10 and 5-by-10 are fairly common and represent a good proxy for the amount of wind that can be harvested at a given location. A wind farm in open, flat terrain generally requires about 40 acres per megawatt of installed capacity. A wind plant on a ridgeline in hilly terrain will require much less space — as little as two acres per megawatt.

Offshore wind obviously does not require land, but it presents other issues in terms of the need to co-exist with marine life and activities, potential interference with shipping lines, and the need to lease concessions through the federal government in order to operate in public territory.

Q26. What are the costs associated with onshore wind power?

A26. (SR) Wind power costs include capital costs and operation and maintenance ("O&M") costs. Capital costs are best referred to in terms of dollars per kilowatt ("KW") of capacity installed. Until 2-3 years ago, a good rule of thumb for onshore wind power capital costs was that a turbine would cost approximately $1,500 per KW and a wind farm would have a total installed overnight[17] cost of $2,000 per KW.[18] However, in the last couple of years, prices for wind turbines have dropped due to oversupply. Today's wind turbine prices are approaching $1,000 per KW, with total

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16 New York State Energy Research & Development Authority, "Wind Power Project Site – Identification and Land Requirements," October 2005 (Exh. APL000011).

17 Unless otherwise stated, "installed cost" refers to overnight costs (*i.e.*, excludes costs for interest during construction).

18 Department of Energy, Lawrence Berkley National Laboratory, "2009 Wind Technologies Market Report," 2009 (Exh. APL000008).

installed wind farm costs falling to around $1,500 per KW.[19] However, on the East Coast, the currently accessible wind resources are located on mountain ridges in the Appalachian region, are typically smaller in size, and therefore are more expensive to harvest. East Coast installation costs are likely to be well above $1,500 per KW. For reference, the 2011 Long-Term Electricity Report ("LTER") for Maryland assumes installed cost for onshore wind farms at $2,200 per KW, decreasing to $1,800 per KW after 2011.[20] O&M costs are typically in the $10 to $15 per MWh range, but vary significantly depending on location, and wind farm scale (larger farms enjoy significant economies of scale). O&M costs include land rent, insurance, maintenance and spare parts, and owner's overhead. The LTER for Maryland assumes $11 per MWh for O&M.[21]

Q27. What about offshore wind power?

A27. (SR) Offshore wind farms are significantly more expensive than onshore farms. While there are some limited cost advantages for an offshore wind farm — most notably the fact that offshore rotors can be allowed to rotate faster, which implies lower torque and therefore lighter, less costly drive train components — these relatively small cost advantages are greatly overwhelmed by the additional costs associated with components resistant to corrosive salt waters, resilience to tropical and extra-tropical storms and waves, long distance electrical transmission on high-

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19 John Blau, "Oversupply Causes Drop in Wind Turbine Prices," October 10, 2011 (Exh. APL000013).

20 Exeter Associates, Inc., "Long-Term Electricity Report for Maryland," Prepared for the Maryland Department of Natural Resources, September 23, 2011 (Exh. APL000005).

21 *Id.*

voltage submarine cables, turbine maintenance at sea, and accommodation of maintenance personnel. Additionally, building an offshore wind farm requires development of necessary support infrastructure, including costs for customized vessels, port and harbor upgrades, new manufacturing facilities, and workforce training.

According to NREL, capital costs for offshore wind installations are estimated to be twice as high as land-based systems, with some of the extra cost being partially offset by higher capacity factors.[22] Another recent estimate from the Energy Information Administration puts the cost of offshore wind at 2.5 times that of onshore.[23]

Additionally, the projects in the United States that have been announced recently had estimated capital costs that are many times the typical cost of onshore wind farms:

- The Deepwater project in Rhode Island was announced in October 2011 with a price tag of $205 million for 30 MW, which is over $6,000 per KW, or more than four times as expensive as comparable onshore wind farms.[24]

- Estimates for the larger Cape Wind project have not been made public from the company, but it has been reported that the Massachusetts Attorney General's office estimated the project cost at $2.62 billion, which is also close to $6,000 per KW, and four times as expensive as comparable onshore wind farms.[25]

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22 NREL 2010 (Exh. APL000007).

23 Department of Energy, Energy Information Administration, DOE/EIA-0383, "Annual Energy Outlook 2011," Table 1, December 2010 (Exh. APL000014).

24 "Deepwater to build first U.S. offshore wind farm," Reuters, October 13, 2011 (Exh. APL000015).

25 "2 Mass. utilities make very different power deals," Associated Press, March 27, 2011 (Exh. APL000016).

- In August 2010, Duke Energy canceled plans to erect three demonstration wind turbines in North Carolina's Pamlico Sound, between the mainland and the state's Outer Banks. After a year of in-depth study and collaboration with the University of North Carolina at Chapel Hill, Duke Energy concluded that the fixed costs associated with permitting, design, and construction would render the small-scale project not economically viable. Cost estimates for the Pamlico Sound project exceeded $8,000 per KW.[26]

As was experienced with land-based wind systems over the past two decades, offshore wind costs would be expected to drop with greater experience, increased deployment, and improved technology. In the meantime, some manufacturers are designing larger wind turbines capable of generating more electricity per turbine. Several manufacturers are considering 10-MW turbine designs, and programs such as UpWind in the European Union are developing the tools to support these larger machines. The extent to which any of these efforts will be successful in reducing the high cost of offshore wind is, however, speculative at present.

Although there is no direct experience with offshore wind in the United States, O&M costs of offshore wind farms are also likely to be significantly higher than onshore wind farms, around $20 per MWh and above. For reference, the LTER for Maryland assumes an installed capital cost of $4,460 per KW and an O&M cost of $21 per MWh for offshore wind.[27]

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26 Duke Energy, "2010-2011 Sustainability Report," Another Strong Year for Renewables, 2011 (Exh. APL000017); Wind Energy News, "Duke Energy Axes North Carolina Offshore Wind Pilot," August 20, 2010 (Exh. APL000018).

27 LTER 2010 (Exh. APL000005).

Q28. What are the permitting issues and development times associated with onshore wind power?

A28. (SR) Depending upon the size and potential impact of the project, regulating bodies at the local, state, and federal levels may participate in the permitting process for wind farms.

For onshore wind, at the local level, the local planning commission, zoning board, city council, or county board of supervisors or commissioners, generally govern permitting. Many projects may also require some form of local grading or building permit to assure compliance with structural, mechanical, and electrical codes. At the state level, permits may be required from natural resource and environmental protection agencies, historic preservation offices, industrial development and regulation agencies, public utility commissions, and siting boards. Federal permitting authorities include federal land management agencies (such as the U.S. Forest Service), the Federal Aviation Administration ("FAA"), and the U.S. Fish and Wildlife Service.

Typical steps in permitting include pre-application, application review, decision making, and administrative and judicial review. Issues that might be addressed during the permitting process for onshore wind farms include land use, noise, impact on birds and other biological resources, visual impact, soil erosion, water quality, public health and safety, cultural and paleontological resources, socioeconomics, public service, and infrastructure, solid and hazardous wastes, and air quality and climate.

The length of time required to receive a permit varies from project to project, but onshore wind farms can be brought on line faster than most other types of power-generating facilities. The length of construction depends primarily upon the number of turbines to be erected, the terrain, and weather conditions. Under the best circumstances, this can all be accomplished within one to two years.[28]

Q29. Is permitting more difficult for offshore wind power projects?

A29. (SR) Yes, the permitting process for offshore wind farms is much more complex. There is limited experience in the United States and the only project that has received the required permits is the Cape Wind project off the coast of Massachusetts. The Cape Wind project was announced in 2001 and received its local and state permits in 2009 and most federal permits in 2010 and 2011, including those from the Department of the Interior ("DOI"), the FAA, the Mineral Management Service ("MMS") now called the Bureau of Ocean Energy Management ("BOEM"), the Environmental Protection Agency ("EPA"), and the U.S. Army Corps of Engineers. The permitting process has taken over ten years.

Given the significant amount of public controversy over the high costs and impact of offshore wind, as well as the number of local, state, and federal government agencies involved in permitting an offshore wind farm, it is likely that any offshore project in the United States will go through a similarly lengthy permitting process. This remains true even though the federal government, through the DOI's "Smart from the

[28] National Wind Coordinating Committee, "Permitting of Wind Energy Facilities," August 2002 (Exh. APL000019).

Start" initiative, is taking steps to attempt to reduce the length of the permitting process, at least at the Federal level.

Q30. What are the estimated development times for wind power projects?

A30. (SR) The time needed to bring a wind farm to operation is dependent not only on the permitting process, but also on commercial considerations. Commercial development steps include negotiations of power purchase agreements ("PPA"), turbine supplier agreements, leases, utilities, construction contracts, and interconnection and transmission agreements. Delays involving any of these steps can significantly add to the time necessary to bring a project online. In addition, before power can be connected to the grid, there is, of course, the time needed to construct the project.

The commercial development of onshore wind farms is fairly well understood, with standardized contracts and fairly straightforward development and construction processes. On balance, one can expect an onshore wind farm to be online and generating electricity within 3 to 5 years from conception.

However, once again, offshore wind farms face a very different set of circumstances. In addition to the much longer permitting process, as previously discussed, offshore wind farms must develop a local supply chain structure, conduct a much more complicated negotiation of power contracts (due to very high impact to ratepayers), obtain leases from the federal government, and endure a longer construction timeline. Therefore, for offshore wind farms, one should expect overall development times in the 10-15 year range.

Q31. You mentioned a Department of Interior program. Can you please provide a brief overview of activities by Interior involving offshore wind?

A31. (SR) DOI launched the "Smart from the Start" Atlantic Outer Continental Shelf ("OCS") initiative in the fall of 2010.[29] The main objective of the initiative is to accelerate responsible renewable wind energy development on the Atlantic OCS by using appropriate designated areas, coordinated environmental studies, large-scale planning, and expedited approval processes. The program aims to:

- Simplify the approval process for individual proposed projects and eliminate unnecessary regulatory requirements;
- Implement a comprehensive, expedited leasing framework for Atlantic wind by identifying Wind Energy Areas ("WEA") in the Atlantic, organizing, financing and implementing the gathering of information from key agencies regarding the environmental and geophysical attributes and other uses of these WEAs, and assembling the information in a publicly available format; and
- Move, on a parallel (but separate) track, to process applications to build offshore transmission lines.

DOI has already taken several steps to implement the program.[30] For example, the Cape Wind project in Massachusetts signed the first lease with DOI in October 2010.[31] Nevertheless, even if this program addresses a number of the issues related to developing offshore wind farms, it does not necessarily ensure that future offshore

29 Department of the Interior, "Frequently Asked Questions: 'Smart from the Start' Atlantic OCS Offshore Wind Initiative," 2010 (Exh. APL000020); Department of the Interior Press Release, "Salazar Launches 'Smart from the Start' Initiative to Speed Offshore Wind Energy Development off the Atlantic Coast," November 23, 2010 (Exh. APL000021).

30 Bureau of Ocean Energy Management, Regulation, and Enforcement, "Fact Sheet: Renewable Energy on the Outer Continental Shelf," 2011 (Exh. APL000022).

31 Department of the Interior Press Release, "Salazar Signs First U.S. Offshore Commercial Wind Energy Lease with Cape Wind Associates, LLC," December 6, 2010 (Exh. APL000023).

wind projects will be expedited owing to other state and local permitting requirements and regulatory approvals.

Q32. Please provide a brief summary of wind power potential in Maryland (offshore and onshore).

A32. (SR) A common way to look at wind power potential is to use "wind classes." Wind resources are classified in wind class from 1 to 7. Wind classes 1 and 2 are not suitable for power generation. Most onshore wind farms are located in class 3 and 4 areas, and offshore wind farms could go as high as class 5 and 6.[32] The vast majority of onshore wind potential in the United States is located in the so-called wind corridor, which is the area immediately to the east of the Rocky Mountains. On the East Coast, the only locations with higher-than-class 3 winds, which are suitable for some limited wind developments, are the ridge tops in the Appalachian region. In terms of potential power generation capacity for onshore wind, NREL estimates that there is 1,483 MW of onshore wind potential in the State of Maryland, which would generate approximately 500 MW(e) on average.[33]

A study by the University of Delaware estimated the potential for offshore wind off the coast of Maryland, using an existing NOAA buoy to measure wind speed and wind patterns, applying industry averages, and accounting for marine, avian, visual, shipping conflict, and military conflict areas. The results show that the overall

[32] National Renewable Energy Laboratory, "United States Wind Resource Map," 2009 (Exh. APL000024).

[33] National Renewable Energy Laboratory, "Estimates of Windy Land Area and Wind Energy Potential, by State, for areas >= 30% Capacity Factor at 80 meters," Feb. 4, 2010 (Updated April 13, 2011 to add Alaska and Hawaii) (Exh. APL000025).

offshore wind potential is 14,625 MW of capacity in Maryland in shallow waters (*i.e.*, less than 35-meter deep, which allows for the use of proven technology), generating approximately 5,000 MW(e) on average.[34]

Q33. What is the status of legislative efforts to promote wind power in Maryland?

A33. (SR) The Maryland Offshore Wind Energy Act was introduced during the Maryland legislature's 2011 session, but it did not move forward. The bill would have required investor-owned electric utilities to purchase between 400 and 600 MW of nameplate wind capacity, equivalent to approximately 160-240 MW(e) on average. Each investor-owned electric utility would have been required to purchase a portion of the total offshore wind power proportional to their load share.[35]

At this point in time, it is not clear whether a similar bill will be reintroduced in 2012. Nor is it possible to assess the prospects for passing such a hypothetical bill. In a recent speech at the American Wind Energy Association's Offshore Wind Expo in Baltimore on October 11, 2011, Governor O'Malley did not provide any additional insight as to whether a new offshore wind bill would be re-introduced.[36]

34 University of Delaware's Center for Carbon-free Power Integration, College of Earth, Ocean, and Environment, "Maryland's Offshore Wind Power Potential," February 1, 2010 (Exh. APL000010).

35 Maryland State Administration, "Maryland Offshore Wind Energy Act," 2011 (Exh. APL000027).

36 Statement of Gov. O'Malley to American Wind Energy Association, October 11, 2011 (Exh. APL000028).

Q34. Please describe the conclusions of the Maryland Department of Natural Resources' recent LTER for Maryland regarding wind power.

A34. (SR) In the LTER "Reference" case, the levels required by the Maryland Renewable Portfolio Standard ("RPS") are fully met every year with the lowest-cost available renewable energy source.[37] Tier 1 non-solar energy resources in PJM currently generate approximately 20,100 GWh of electricity per year, which is more than enough to supply the regional 2010 Tier 1 non-solar renewable energy requirements established in Maryland and those of the other PJM states with RPSs. Development of Tier 1 non-solar renewable resources is assumed to keep pace with demand so that the region's RPS requirements are fully met throughout the study period. It is also assumed that increasing renewable energy requirements in Maryland would be fully met through in-state renewable generation sources.

According to the model used for the report, the result is that 190 MW of onshore wind would be added over the next 10 years, equivalent to 57 MW(e) on average (30% capacity factor), and no offshore wind. The existing Roth Rock and Criterion projects (discussed further below) already account for 120 MW of additional onshore wind capacity, so there would only be an additional 70 MW installed beyond those two projects in the LTER reference case. The majority of the Maryland RPS would be satisfied through non-wind renewable sources, such as biomass and landfill gas.

The LTER for Maryland also considers a hypothetical "high renewable scenario." In this scenario, the scope of the Maryland RPS is expanded to require 30% renewable energy by 2030. Under this scenario, nothing changes until 2020 (190 MW of

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37 LTER (Exh. APL000005).

onshore wind, no offshore wind). However, between 2020 and 2030, this scenario results in the addition of 1,220 MW of onshore wind (366 MW(e)), along with 2,500 MW of offshore wind (1,000 MW(e) at a 40% capacity factor).[38] The underlying calculation is that 75% of the available onshore wind resources would be used up, and the remaining balance of unmet RPS quota would be filled out through the only remaining renewable resource (offshore wind). This scenario is, at best, speculative and would require significant changes in policy and project economics.

As discussed by others in this testimony, even assuming these onshore and offshore resources could be tapped, converting the energy to "baseload" power would require some form of storage system.

Q35. Please provide a brief overview of existing wind projects in Maryland or nearby region.

A35. (SR) There are currently two operating large-scale wind projects in Maryland with a total of 120 MW installed capacity (36 MW(e)). The first project is the 70 MW Criterion project in Western Maryland, which is owned by Constellation, and has been in operation since December 2010.[39] The Criterion Project was originally announced in 2002 and took 8 years of development to come on line. The second

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38 The "MW(e)" values presented here and elsewhere in the testimony for wind power are average values based on a capacity factor of 30%.

39 Constellation Energy, "Criterion Wind Project, Garret County, Maryland" (accessed October 20, 2011) (Exh. APL000029).

project is the 50 MW Roth Rock project, which is also in Western Maryland and is owned by Gestamp Wind North America.[40]

Outside of Maryland, there are other wind farms in the nearby region, including the following:

- Pennsylvania has 751 MW (225 MW(e)) of wind capacity currently on line, and an additional 177 MW (53 MW(e)) is under construction. Operating projects include: Locust Ridge, Armenia Mountain, Allegheny Ridge, North Allegheny, Waymart, Casselman, Bear Creek, Forward, Green Mountain, Lookout, Meyersdale, Mill Run, Stonycreek, and Somerset.[41]

- West Virginia has 431 MW (129 MW(e)) of wind capacity currently on line, and an additional 147 MW (44 MW(e)) is under construction. Operating projects include: Mount Storm, Beech Ridge, and Mountaineer.[42]

- Virginia has no operating project, but the Highland 38 MW (11 MW(e)) project is currently under construction.[43]

Overall, within the PJM region, most of the wind generation came from the wind-rich Midwest regions of PJM (Ohio, Michigan, Indiana, and Illinois).

No offshore wind projects are currently operational in Maryland or the mid-Atlantic region.

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40 Gestamp Wind, "Roth Rock," 2011 (Exh. APL000030).

41 American Wind Energy Association, "Wind Energy Facts: Pennsylvania," August 2011 (Exh. APL000031).

42 American Wind Energy Association, "Wind Energy Facts: West Virginia," August 2011 (Exh. APL000032).

43 American Wind Energy Association, "Wind Energy Facts: Virginia," August 2011 (Exh. APL000033); Highland New Wind Farm Development, LLC, "Our Vision" (accessed October 20, 2011) (Exh. APL000034).

Q36. Please provide a brief overview of planned wind projects in Maryland or the nearby region.

A36. (SR) Two onshore projects have gone through a significant number of development steps in Maryland:

- The Savage Mountain 40 MW project was originally proposed for Western Maryland in 2002, from US Windforce, and received permits to construct in 2003. However, the project was cancelled in 2010, due to its inability to secure a PPA.

- The Dan's Mountain 69.6 MW project, also developed by US Windforce, is apparently still under development in Western Maryland, and is currently going through the permitting process.[44]

Additionally, according to the PJM interconnection queue, there are over 600 MW of projects in Maryland that have applied for interconnection. However, queue numbers should not be construed as being representative of future installed capacity, since the majority of projects apply for interconnection early on, and most of the projects will never come to fruition. I am not aware that any of these projects have signed PPAs. Similarly, between Pennsylvania, West Virginia, and Virginia, there are more than 5,000 MW of wind projects in the queue. If all those projects came to fruition, that would represent harvesting 75% of the total wind potential in those states. But, once again, only a tiny fraction of these projects are likely to go forward.

With respect to offshore projects, Bluewater Wind is currently developing projects in Delaware, New York, New Jersey, Maryland, and New England. The Bluewater Delaware 450 MW project has been under development for over 5 years and is currently the most advanced project of the Bluewater portfolio. The project signed a final PPA in 2008 with Delmarva Power for 559,000 MWh of electricity (200 MW at

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44 US Windforce, "Dans Mountain" (accessed October 21, 2011) (Exh. APL000035).

~32% expected capacity factor), and has obtained exclusive rights to negotiate a lease with the federal government under the "Smart from the Start" program.[45] However, the Bluewater Delaware project is still very far from being operational. First, the permitting process still has several hurdles to overcome, and the Cape Wind project showed the complexity of getting such large offshore wind projects through the permitting process. Second, the revenue side of the project is still not resolved. The PPA signed with Delmarva Power covers only 200 MW of output, or 559,000 MWh, and 160,000 Renewable Energy Certificates ("REC"), with each REC accounting for 3.5 "regular" RECs, as legislated through Delaware Senate Bill No. 328.[46] When capacity payments are included, the PPA effectively provides approximately $150 per MWh, in 2011 dollars, for 559,000 MWh. That price is likely to fall short of what is needed to make the project economically viable, even considering federal incentives, unless the remaining 399,000 RECs can be sold at a very high price. Selling RECs at a high price does not appear likely in today's depressed REC market. So, in my opinion, the project is unlikely to move forward unless the PPA is significantly renegotiated or additional incentives are provided.

Furthermore, the estimated impact to consumers, provided in the 2008 analysis, is likely to be significantly underestimated.[47] Natural gas price projections, electricity

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45 Department of the Interior Press Release, "Interior Initiates Process for First "Smart from the Start" Lease for Commercial Wind Power Offshore Delaware," March 24, 2011 (Exh. APL000036).

46 New England Opportunities, Inc. et al., "Report on Final Power Purchase Agreement between Delmarva Power and Bluewater Wind Delaware LLC," July 3, 2008 (Exh. APL000037).

47 *See id.*

prices, and demand forecasts in the PPA were all based on, what we can see today with the benefit of hindsight, was the top of the market. In that respect, there is likely to be pressure to further reduce the impact on ratepayers associated with the PPA, while the opposite would be necessary to make the project successful.

The other Bluewater projects in Maryland, New York, and New Jersey are at the very early stages of development. Similarly, the Atlantic Wind Connection project, which has formed to build a DC line to allow 7000 MW of offshore wind to connect to the grid, has taken important steps (FERC approval, application for right-of-way, and commitments from strong financial partners), but it is also still very early in the development process.[48] These projects are all many years from completion.

Q37. What are your expectations regarding installed wind power capacity in Maryland over the next 10 years?

A37. (SR) My expectations are in line with what is outlined in the reference case of the LTER for Maryland. The LTER reference case is based on the current regulatory environment and RPS. I think this is the appropriate scenario to look at because an expansion of RPS requirements beyond the current RPS is highly speculative.

I expect wind power capacity to be added only to the extent that it is used to fulfill the RPS requirements and is the lowest-cost renewable option. Beyond the RPS requirements, I would expect no additional wind capacity to come on line, since, without receiving a REC, wind would not be competitive with natural gas in

48 David Roberts, "Answer to cheap power is blowing in offshore wind: Atlantic Wind Connection sees hundreds of miles of turbines making efficient energy," May 10, 2011 (Exh. APL000006).

Maryland. Incidentally, current incentives that improve wind power economics may disappear in the future.[49]

The LTER reference case shows 190 MW of additional capacity coming on line. In reality, 120 MW of that capacity has already come on line, through the Criterion and Roth Rock projects, which leaves an additional 70 MW of installed wind capacity to be expected over the next few years. This is equivalent to 21 MW(e) on average. In the unlikely, but plausible, case that all of the new renewable energy necessary to satisfy the RPS were to come from wind power, wind power would have to provide up to approximately 1.5 million MWh per year. That would approximately represent an additional 570 MW of wind power, or 170 MW(e) on average.

A final consideration is that renewable power generation is mostly driven by RPS compliance, which is defined as a percentage of the total electric load. Successful energy efficiency and energy conservation programs would therefore result in lower loads and proportionally lower amounts of renewable energy being installed.

Therefore, in my professional opinion, I expect approximately 21 MW(e) of wind power capacity to come on line in the next few years. Under optimistic (though speculative) conditions, up to 100 MW(e) is possible. Therefore, I consider the NRC Staff's use of 100 MW(e) from wind in the FEIS combination of alternatives to be reasonable.

49 These incentives are discussed further in ¶46.

Q38. In your professional opinion, is the use of CAES in combination with wind turbines to generate 1600 MW(e) in Maryland reasonable in the next 10 years? What about 100 MW(e) or 400 MW(e)?

A38. (SR) As noted above, use of wind power to generate 400 MW(e) in Maryland is not foreseeable in the next 10 years, much less 1600 MW(e). On balance, assuming that the addition of a storage technology was technically and economically feasible,[50] it is plausible, but unlikely, that 100 MW(e) of wind energy could be available in Maryland as "baseload" in the next 10 years. I therefore consider the FEIS analysis of the combination of alternatives to be reasonable. However, 400 MW(e) or 1600 MW(e) of generation is not foreseeable, or even possible.[51]

D. Solar Power

Q39. Please provide a brief overview of solar power technologies.

A39. (SR) Solar power indicates the conversion of the energy from the sun into electricity. There are two main solar technology categories available for utility-scale plants. Each category has several commercially available technologies:

- Concentrated Solar Power ("CSP"), or "thermal solar", in which mirrors concentrate the solar power to heat up a fluid that drives a turbine or an engine. The primary CSP technologies are parabolic trough, power tower, linear Fresnel reflectors, and Stirling systems.

- Photovoltaic ("PV"), in which solar power is converted directly into electricity through the use of cells with semiconductors. The primary PV technologies are crystalline silicon and various types of thin-film (*e.g.*, cadmium-telluride or gallium-arsenide). In some applications, it is also

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50 A typical CAES system adds significant cost to a wind farm and would likely make wind non-competitive against other alternatives — that is, utilities would elect to pay the $40 per MWh RPS Alternative Compliance Payment ("ACP") rather than purchase wind power.

51 Additional wind power installed capacity is very unlikely to ever exceed 200 MW(e) under the current regulatory framework.

possible to concentrate the sun rays, before they hit the solar panel (Concentrated Photovoltaic, "CPV").

In general, CSP and CPV work only in dry sunny climates. In the United States, this means that only the Southwest is a viable option for these technologies. PV is more flexible and works well in diffuse light situations, which is often the case in the mid-Atlantic region. Therefore, for the purpose of my testimony, I will limit the discussion to solar PV technology.

Q40. What are the capacity factors for solar PV?

A40. (SR) Because solar PV power generates electricity only when the sun is shining, capacity factors are relatively low. This is exacerbated by evening, cloudy, and other low-light periods. Fixed tilt (at latitude) capacity factors are 14%-24% for Seattle to Phoenix, with most of the East Coast typically around 14-18%.[52] Tracking systems can increase the capacity factor significantly, but also add to the cost. For reference, the LTER for Maryland assumes a solar capacity factor of 15%, and the recently announced 17.1 MW solar plant in Emmitsburg, Maryland, also plans to operate with a capacity factor just under 15%.[53]

Q41. What are the land use implications of solar PV?

A41. (SR) Utility-scale solar plants use a significant amount of land, typically between 2.5 and 12.4 acres of land per MW installed, depending on local climate, panel

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52 Department of Energy, National Renewable Energy Laboratory, "2008 Solar Technologies Market Report," January 2010 (Exh. APL000039).

53 LTER (Exh. APL000005).

efficiency, and panel distribution.[54] Most utility-scale installations fall within the 4 to 8 acres per MW range. For reference, the Emmitsburg solar project uses 100 acres, or approximately 6 acres per MW.

Smaller solar projects, up to several hundred KW, can often be located on rooftops. Placement of solar panels on rooftops is common for residential and commercial installations. For these types of projects, land use requirements are minimal since the panels are placed on pre-existing structures.

Q42. Can you give a sense of the costs associated with solar PV installations?

A42. (SR) In 2010, the typical cost of utility-scale PV plants was approximately $3,400 per KW, down from $8,000 per KW in 2004.[55] Since then, there have been further price decreases, although some of those decreases may be due to a temporary supply/demand imbalance. Prices for solar panels, in particular, have decreased through 2011 and can now be found on the market for around $1 per W. This equates to an installed cost for solar plants of less than $3,000 per KW.[56] Thin-film solar plants tend to cost less than crystal silicon, but also have lower efficiency. For non-utility-scale installations, such as rooftops, the costs are significantly higher. Estimates from installers in Maryland for rooftop installations in September 2011

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54 *Id.*

55 Department of Energy Solar Energies Technology Program, "The Prospect for $1/Watt Electricity from Solar," August 10, 2010 (Exh. APL000040).

56 $3,400 per KW is roughly the cost that Constellation has estimated for the Emmitsburg solar project. *See* Constellation Energy – Emmitsburg Solar, "Constellation Energy to Develop Maryland's Largest Solar Photovoltaic Power System," 2011 (Exh. APL000041).

were around $6,000 per KW for a ~5 KW system. Larger commercial installations will fall somewhere in between the cost of utility-scale plants and residential rooftops. Annual O&M costs for PV systems are fairly low, typically accounting for less than 1% of the initial capital investments, or somewhere in the order of $10 to $15 per MWh.

Q43. Please provide a brief summary of solar power potential in Maryland.

A43. (SR) The raw potential for solar power is certainly high. At 6-7 acres per MW, it is just a question of how many acres can be devoted to solar power. If 10% of the land in Maryland were covered by solar panels, there would be 20,000 MW(e). However, such numbers are of little interest in the case of solar, because the economics of solar are such that building solar power plants makes economic sense only inasmuch as it is mandated through state standards and/or federal incentives are made available.

Q44. What is the effect of incentives on solar PV deployment?

A44. (SR) Without any state or federal incentive, solar would have a levelized cost of more than $200 per MWh for utility-scale power plants and $400-500 per MWh for rooftop installations. Even if the cost of solar power decreases dramatically, solar power will not be competitive with conventional power sources for the next decade at the very least. Therefore, the potential for solar power is limited to the demand generated by governmental mandates and future incentives, which are speculative at best.

To further illustrate the point, Maryland Solar Renewable Energy Certificates ("SREC") in 2011 have traded at around $200 per MWh.[57] At present, there is a

57 SREC Trade, "SREC Market Prices," 2011 (Exh. APL000042).

strong incentive to build solar plants in Maryland, considering that the current Solar Alternative Compliance Payment ("SACP") is $400 per MWh. However, in the future, the amount of solar power that is likely to come on line will be capped by satisfaction of the solar carve-out in the RPS (2% by 2022) or at a lower level if the SACP becomes lower than the required economically-viable SREC price.

Q45. What is the status of legislative efforts to promote solar power in Maryland?

A45. (SR) To the best of my knowledge, there is currently no legislative effort underway to promote solar power in Maryland other than the 2% solar carve-out in the RPS, which is currently in effect. There are programs aimed at incentivizing renewable energy, such as the solar Sunburst Program (financed under the American Recovery and Reinvestment Act of 2009) and the Maryland Clean Energy Grant Program, which provides $ 500 per KW of solar power (DC) installed. There are also broader initiatives aimed at reducing greenhouse gas emissions, such as the Regional Greenhouse Gas Initiative ("RGGI"), and the Maryland Greenhouse Gas Reduction Act ("GGRA").

Q46. Are there federal incentives that could promote development of solar PV or wind power in Maryland?

A46. (SR) Renewable energy development over the last few years has been greatly supported through federal incentives, such as the Production Tax Credit ("PTC"), the Investment Tax Credit ("ITC"), which was initially made available only for solar, and the 1705 Loan Guarantee Program.[58] However, these incentives, which have greatly facilitated the development of renewable energy, are expiring. Given the very

58 Many of these incentives are also available for wind generation projects.

difficult and unique fiscal and political conditions facing the United States, they may not be renewed.

The Section 45 PTC provides a $22 per MWh credit to qualifying facilities for the first 10 years of operation. It was initially enacted through the Energy Policy Act of 1992, and was renewed four times. However, it was allowed to sunset temporarily on three occasions, creating a stop-and-go situation that, for example, did not allow for the wind energy to gain momentum until 5-6 years ago. The PTC is slated to expire at the end of 2012, and there is significant uncertainty as to whether it will be renewed.

The 1603 Program was enacted under the American Recovery and Reinvestment Act ("ARRA") of 2009 and provides a rebate for 30% of the installed cost of a qualifying facility. However, it only applies to facilities that have initiated construction before the end of 2011 and is not expected to be renewed.

The 1705 Loan Guarantee Program was also enacted under ARRA and allows developers to reduce financing costs for projects that are "shovel-ready." The program expired on September 30, 2011, and I do not expect it to be renewed.

Solar power still enjoys additional incentives, most notably the Section 48 ITC, which provides a tax credit equal to 30% of the installed cost of qualifying facilities. The Section 48 ITC was enacted under the Energy Policy Act of 2005 and is not set to expire until 2016. Solar plants also qualify for various depreciation provisions in the U.S. Tax Code.

Q47. Are there different market forces at work when considering renewable energy development as opposed to traditional baseload generation?

A47. (SR) Effectively, there are two markets in the electricity industry: one for green energy and one for brown energy.[59] This is consistent with the overall approach of the LTER for Maryland, as well as my own experience developing renewable energy projects.

The two markets are not entirely separate, but they are fairly distinct. The green energy market is driven by RPS compliance — that is, renewable energy sources compete against each other. As long as REC prices do not exceed ACPs ($40 per MWh for non-solar Tier 1 resources in Maryland), green sources do not have to compete against brown energy. Once the green market is exhausted (*i.e.*, the RPS is satisfied), renewable energy sources would have to compete against brown sources without the advantage of REC payments. With few limited exceptions, renewable energy sources are almost always more expensive.

It is always possible for policymakers to create sub-markets by mandating them. Renewable energy as a whole is a mandated market, and solar in particular is mandated through carve-outs. To spur offshore wind developments in Maryland, it would be necessary to mandate a third green energy market (beyond non-solar Tier 1 resources and solar), or to provide equivalent special provisions (similar to what has been done in Delaware, where offshore wind RECs count for 3.5x), or expand the

[59] This discussion applies equally to wind power, but is discussed here because of the specific carve-out for solar in the Maryland RPS. In Maryland, the green market is further split into the solar market and the non-solar market, because of the solar carve-out requirement in the RPS.

RPS to 30% to be satisfied with in-state resources and with a very high ACP. As discussed above, under the latter scenario, Maryland effectively would run out of available onshore wind and other renewable sources, and then would need to tap into offshore wind to meet the RPS. However, these scenarios all involve speculation. None could be considered reasonable at present.

Q48. Describe the conclusions of the Maryland Department of Natural Resources' recent LTER for Maryland regarding solar power.

A48. (SR) The LTER for Maryland estimates that future installed capacity of solar power will be closely linked to the levels required in the solar RPS carve-out (2% by 2022). The LTER reference case assumes that new solar power will be installed to meet the growing requirements for solar through 2018 and, up to that point, there will be availability of SRECs at prices below the SACP.[60] After 2018, the LTER reference case assumes that the additional requirements for solar power will not be met through new physical installations; rather, it is assumed that the utilities will elect to pay the SACP. This is driven by the fact that the SACP will decrease over time from $400 per MWh today to $150 per MWh in 2019, and, at that point, SRECs will not be available below that price level. In terms of installed capacity, the LTER reference case predicts that there will be 498 MW of new solar capacity installed in Maryland over the next 10 years, equivalent to approximately 75 MW(e) on average. This is consistent with the NRC Staff's use of 75 MW(e) in the combination of alternatives considered in the FEIS (though, as discussed below, this is not, by itself, "baseload" power).

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60 This is true at present. SRECs are currently priced at ~$200 per MWh, while the SACP is $400 per MWh.

The high renewable scenario assumes that the entire 2% solar carve-out will be met through physical solar installations, and none through SACPs. The additional RPS requirements imposed under this scenario (30% by 2030) will be met through lower-cost renewables (onshore wind first, and then offshore wind). Thus, only limited new solar power installations are expected beyond 2020. In terms of installed capacity, the LTER high renewables scenario forecasts that there will be 785 MW of additional solar capacity by 2020 (approximately 120 MW(e)), 1068 MW by 2022 (160 MW(e)), and 1158 MW by 2030 (174 MW(e)). This scenario is, at best, speculative.

Q49. Please provide a brief overview of existing and projected utility-scale solar projects in Maryland or the nearby region.

A49. (SR) In Maryland, the only utility-scale operating project is the 2.2 MW University of Maryland Eastern Shore plant. There is also a large commercial installation (1.8 MW) on McCormick's Hunt Valley Distribution Center. There are however, some larger projects that are expected to come on line over the next couple of years including the 17.4 MW Constellation Energy project in Emmitsburg, a 5.5 MW Southern Maryland Electric Cooperative project in Hughesville, and a 20.0 MW Maryland Solar LLC project close to Hagerstown.

According to the Solar Energy Industries Association, the surrounding states also have some solar projects in construction or development, including the following:

- Pennsylvania: 6 MW in operation, 1 MW in construction, and 52 MW in development

- Delaware: 10 MW in operation (Dover Sun Park)[61]

Q50. What are your expectations regarding installed solar power capacity in Maryland over the next 10 years?

A50. (SR) My expectations are generally in line with the LTER reference case scenario, which estimates approximately 75 MW(e) of new solar installed capacity by 2020. It is plausible, though unlikely, that SRECs will remain competitive against ACPs beyond 2018 considering the decline of solar panel prices, the potential for technological breakthroughs, and the possibility that federal incentives will be extended. If so, all of the solar 2% carve-out would be met through physical installations in Maryland and would amount to 160 MW(e) of new solar power over the next 10 years. It is highly unlikely that there will be any solar power installation beyond the 160 MW(e) level in the absence of a significant policy shift, which is highly speculative.

Q51. In your professional opinion, is generation of 1600 MW(e) in Maryland reasonably foreseeable? What about 75 MW(e) or 300 MW(e) of solar power, in conjunction with CAES, as baseload?

A51. (SR) 1600 MW(e) of solar power in Maryland is simply not possible in that time frame. As I noted previously, increases in installed solar capacities are likely to be driven by Maryland's RPS. In my professional opinion, installation of the equivalent of 75 MW(e) baseload (assuming that energy storage is technically and economically feasible) is a reasonable assumption. This is broadly in line with the values assumed in the NRC Staff's combination of energy alternatives. Installation of the equivalent

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61 Solar Energy Industries Association, "Utility-Scale Solar Projects in the United States Operating, Under Construction, or Under Development," October 14, 20114 (Exh. APL000043).

of 300 MW(e) of baseload solar is highly unlikely in the next 10-15 years.[62] On balance, the NRC Staff assumption of 75 MW(e) of solar power in the FEIS analysis of a combination of alternatives is reasonable.

E. CAES Systems

Q52. Please provide a brief overview of CAES technologies?

A52. (SVDL) The basic objective of utility-scale storage of electricity is to store excess energy or energy with low production costs produced during off-demand periods and to use this energy at a later date to generate power during periods of higher demand. CAES is analogous to pumped hydro storage ("PHS") where electricity is converted to a stored energy form as high pressure compressed air or water elevated from a lower reservoir to a higher reservoir. Recovery from compressed air is accomplished by expanding the high pressure air with Expander Turbines, which requires energy input (fuel) to heat the air, and the resulting mechanical power drives a generator to produce electric power. For PHS, the water volume at the higher elevation is released to drive a hydro turbine, coupled with a generator at the lower elevation. No additional fuel is required.[63] Both PHS and CAES can only deliver power to the extent that the storage facility can deliver; after that, recharging is necessary.

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62 Assuming a CAES plant could be developed, this hypothetical scenario could be met if, as discussed in ¶50, all of the solar 2% carve-out was met through physical installations in Maryland, generating 160 MW(e) of solar power. However, as I also explained, this is unlikely to occur and would not be a reasonable assumption for the FEIS combination of alternatives.

63 Because pumped hydropower plants require no additional fossil fuel and have a level of efficiency of up to 80%, they are much more efficient than CAES power plants. However, pumped hydropower plants generally implicate the considerable environmental impact of the reservoir and downstream basin and are costly to develop. *See* American

Air is compressible, which means that it can be stored at higher pressure (1000 psi to 1500+ psi). Underground cavities are suitable for the large volumes required by compressed air storage. While these volumes are much less than that required by PHS, they are still quite substantial and require proper geological characteristics, as discussed later in my testimony. The best candidates for CAES storage are solution-mined salt caverns (lower cost), though natural deep saline aquifer structures and abandoned mines may be suitable to a lesser degree.

Q53. What is the general purpose of a CAES plant?

A53. (SVDL) CAES is not a continuous base load power plant. CAES can, however, provide baseload over a specified daily dispatch based on the energy storage volume of a given reservoir. This storage reservoir, when drawn down, must be recharged by drawing power from other energy sources.

As already mentioned, there are basically only two proven methods available for the feasible storage of bulk energy on a utility scale in the foreseeable future: pumped hydro and larger CAES power plants. Small CAES plants cannot be considered "bulk energy storage," which generally involves plants rated in hundreds of MW-hrs. But, small CAES plants can play a role in smoothing wind energy distribution (absorption) during low load morning demand and to sustain green energy delivery during peak demand cycles.

Wind Energy Association, "Wind Power and Energy Storage," 2011, at 4 (Exh. APL000038).

CAES can contribute valuable benefits to a grid system through load management (shifting) regulation, spinning reserve, rapid ramp capabilities. CAES plants can also be used to meet daily demand cycle variations (keep base load plant at best performance levels) and to match renewable energy to capacity, shaping, and firm values. CAES extends the value chain of renewable energy in providing the ancillary services that wind and solar cannot, by themselves, provide as energy sources. While CAES is therefore a useful asset to a utility portfolio and can supplement baseload generation by reducing the variability of renewable energy, it is not a steady 24/7 baseload facility and does not meet the purpose of Calvert Cliffs 3 as articulated in the FEIS.

Q54. How does CAES work?

A54. (SVDL) A CAES power plant splits a conventional industrial gas turbine into a compressor unit for compressing the combustion air and an expansion turbine to generate mechanical power to drive a generator. The basic concept in CAES is the Brayton cycle (gas turbine).[64] The compression cycle is separated from the turbine expansion cycle. Compression of air in a high power density gas turbine absorbs 60% or more of the Power Turbine output, so that almost 2/3 of the fuel energy input is required to drive the compressor. By separating the compression cycle, lower cost power (*e.g.*, off-peak power or excess baseload) or excess wind energy can be utilized to drive the compression cycle. This makes it possible to restrict the use of valuable

[64] Septimus van der Linden: "APS (American Physics Society) Energy Study Working Group-Study on Electricity Storage," August 14th, 2006 (Exh. APL000044).

fossil fuels to heating the pre-compressed air only. This substantially reduces the amount of fossil fuel used and the resulting CO_2 emissions.

When low cost or excess energy is available, the motor/compression unit compresses air into the storage medium (*e.g.*, underground storage). The heat of compression requires cooling of the air before being injected into storage. When the compressed air is released, the stored compressed air is fed into the combustion chamber together with natural gas. The heated compressed air expands in the turbine to drive the generator.[65]

Q55. What is the rated output potential for CAES technology?

A55. (SVDL) The plant ratings are expressed in MW for bulk energy storage. However, the actual output is generally expressed in MW-hours per daily dispatch, as determined by the cavern or reservoir storage. For example, a 15 MW system capable of running 4 hours will deliver 60 MW-hours. The basic unit sizes for CAES, starting at 15 MW, are determined by available gas turbine sizes in the market. Individual units could be rated up to 450 MW. Thus, depending on the storage volume, it is theoretically possible to have a CAES plant with significant energy storage. For example, the Norton Project in Ohio had a planned capacity of 2700 MW, defined by a 338 million cubic feet limestone cavern.

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65 Septimus van der Linden, "Review of CAES Systems Development and current Innovations that could bring commercialization to fruition," EESAT 2007 (Exh. APL000045).

Q56. Please provide brief overview of existing CAES projects.

A56. (SVDL) There are currently only two operating CAES plants. The plant in Huntorf, Germany, operated by E.ON Kraftwerke, was commissioned in 1977-78 by NWK. It was the first CAES power plant in the world. It is designed for turbine operations with 290 MW for 2 hours or compressor operations with 60 MW for 8 hours. The compressed air is stored in two salt caverns with a capacity of 5.3 million cubic feet per cavern. The second CAES plant began operations at the beginning of 1991 in McIntosh, Alabama. This unit is based on the reheat turbine concept (as in Huntorf, Germany). This plant has a generating capacity of 110 MW over 26 hours; the air is stored in a single cavern with a volume of 19.6 million cubic feet.[66]

The two existing operating CAES plants have operated as intended with a high degree of reliability. While similar in cycle concept (reheat high pressure and low pressure combustors), they differed in mission. The Huntorf unit was intended as a back-up to a nuclear plant and was designed for a short fast high-power response (290 MW in 6 minutes) as well as short duration peak-lopping demand. Huntorf does not incorporate a recuperator to preheat the cavern air before entering the HP combustor. The smaller 110 MW unit at McIntosh is recuperated, resulting in lower fuel consumption. The McIntosh facility provides power for longer duration (26 hrs at 100 MW) to balance power demand for the Power South generation portfolio.

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66 Septimus van der Linden, "Bulk Energy Storage Potential in the USA, Current Developments & Future Prospects," 17th International Conference on Efficiency, Costs, Optimization, of Simulation and Environmental Impact of Energy Process Systems, ECOS 2004 (Exh. APL000046).

Q57. Please provide a brief overview of other proposed or planned CAES projects in the United States.

A57. (SVDL) The CAES projects in the United States that have been announced publicly include the following:

- Two DOE-funded CAES projects: (1) a 150 MW salt cavern air storage plant in New York; and (2) a 300 MW project using a depleted gas field for air storage in California;
- Norton Energy Storage, which has a 2700 MW potential, in Ohio. This project was initiated 12 years ago, but there has been no firm decision to proceed;
- Magnum Western Energy Hub in Utah is evaluating a potential 300 MW CAES plant that would include natural gas and liquefied natural gas storage in the same salt dome;
- Apex Energy Texas is assessing a possible 150 MW CAES plant, though no storage facility has been selected to date.
- Iowa Stored Energy Project ("ISEP") is a 270 MW CAES plant with aquifer storage. Although developed for several years, the project was terminated due to porosity limitations in the aquifer sandstone.

Q58. Are there any utility-scale CAES projects under development in Maryland?

A58. (SVDL) To the best of my knowledge, there are no utility-scale CAES projects under development in Maryland.

Q59. What is the amount of storage needed for a CAES plant with underground storage?

A59. (SVDL) For a CAES plant using existing technology, the storage volume is determined by size and hours of operation. For example, the McIntosh facility stores 130 MW-hrs/million cubic feet in cavern with a volume size of 20 million cubic feet. Importantly, the cavern can only be drawn down to about half of the stored capacity to avoid large pressure fluctuations that would damage the salt cavern walls.

A nominal 100 MW CAES system requires 769,230 cubic feet to get 100 MW-hours. To simplify the example, 750,000 cubic feet (based on a higher pressure cavern of 1250 psi vs. 1050 psi at McIntosh) equals 7.5 million cubic feet for 10 hours of operation and no reserve capacity. This means that a full recharge is necessary overnight using much larger (MW rated) compressor units. To extend the discharge another 10 hours (for a total of 20 hours) the cavern volume would need to be increased to 15 million cubic feet.

Q60. Please describe the use of solution-mined caverns for CAES projects and the potential for their use in Maryland.

A60. (SVDL) The storage of natural gas in depleted oil and gas reservoirs, in aquifer formations, or in man-made salt caverns, has been standard practice for many decades in the United States. In Germany and France, over 20% of annual consumption is stored underground. And, some 100 new natural gas storage caverns are currently being constructed in Northern Germany.

Natural reservoirs dominate in terms of amount of gas stored underground world-wide. However, the current enlargements in storage capacities in Europe are concentrated on salt caverns because these storages are much more flexible, having much higher injection and withdrawal rates, and the flexibility to handle frequent cycles.[67] The installation of caverns is dependent on the availability of suitable salt formations. Significant quantities of brine are produced during solution mining. Thus, the ability to dispose the large volumes of brine in an environmentally-

67 Fritz Crotogino et al., "Grid Scale Energy Storage in Salt Caverns," 2011 (Exh. APL000047).

compatible manner is a limitation on CAES siting. For example, the brine could be used as a feed stock at a chemical plant or discharged to the ocean.

An overview of the McIntosh salt cavern gives a sense of issues involved in developing a solution-mined cavern for high pressure air storage (as would be required by a 110 MW CAES power plant). The top of this solution-mined salt cavern is located 1,500 feet underground. The bottom of the cavern is 2,500 feet underground. The air storage volume is 19.6 million cubic feet (usually quoted as 20 million) — 200 ft in diameter and 1,000 feet tall. The cavern walls do not move due to the pressure changes and have the strength 50 times that of the maximum pressure produced for the CAES plant. At full charge, the cavern pressure is 1,100 psig, at full discharge the pressure is 650 psig, the Delta P is the working volume. The air is withdrawn at a rate of 340 lbs/sec (as fast as a wide bodied jet engine) or 1,224,000 lbs/hr delivering 110,000 kW. The air recharging system is designed to compress for 1.7 hrs per hour of generation.

There are no known salt domes or strata salt deposits in Maryland. Thus, salt caverns are not available to support a bulk energy storage CAES plant in Maryland.

Q61. Please describe the use of natural reservoirs for CAES projects and the potential for their use in Maryland.

A61. (SVDL) In addition to salt caverns, natural reservoirs could be used for CAES. One issue with the use of natural reservoirs, such as aquifers or depleted gas fields, is the potential for oxygen in the air to react with the minerals and the microorganisms present in these natural reservoirs. This can result in a loss of oxygen as well as the blockage of the fine pores in the reservoir rocks by the reaction products. To avoid this, caverns are used for energy storage primarily in those regions that have suitable salt formations available. The geological map of the United States identifies potential for siting CAES power plants with suitable storage strata.[68] Maryland would have limited potential with granitic plutonic and sedimentary volcanic rock formations.

Hard rock caverns are used to store hydrocarbon fuels and are potentially the most abundant storage media in the United States.[69] In a hard rock cavern CAES plant, a vertical shaft connects the underground chamber with a surface lake. As air is injected into the chamber, the column of water is pushed up; as air is released, the water fills the void (the same principle as pneumatic/hydraulic accumulator). Hard rock caverns are more expensive to use for CAES, though modern techniques for shaft and cavern excavations have progressed significantly in the past 20 years. To keep the costs at a manageable level, the cavern must be small and the air in the cavern must be maintained at a constant pressure by means of a water compensation system. A water-compensated rock cavern can store about five times as much energy as an uncompensated cavern of the same volume. To the best of my knowledge, there are no hard rock storage sites under consideration for CAES in Maryland. Thus, hard rock storage as the medium for CAES in Maryland is very unlikely for the foreseeable future.

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68 Septimus van der Linden, "Bulk Energy Storage Potential in the USA, Current Developments & Future Prospects," 17th International Conference on Efficiency, Costs, Optimization, of Simulation and Environmental Impact of Energy Process Systems, ECOS 2004, at 30 (Exh. APL000046).

69 Septimus van der Linden, "Hard Rock Caverns-Limestone and Other," March 2011 (Exh. APL000049).

Aquifer storage also has been studied for decades for possible air storage. Dating back to 1982, comprehensive studies on the feasibility of aquifer-based CAES systems were prepared by the Public Service Company of Indiana and Sargent and Lundy Engineers for EPRI. Based on those studies and current investigations, deep saline aquifers with a retaining dome were found to be best suited for CAES.[70] In aquifer storage systems, the retaining dome that secures the air bubble "inverted saucer" (or cap rock) must be of adequate thickness and strength to be impermeable and prevent air loss or blowout. The rock — usually shale, siltstone, or dense carbonate — must be thick enough to prevent fracturing and have low permeability. The rock must also have large capillary forces in order to prevent air from migrating through the media. As a general rule, the pressure of injection is not allowed to exceed the discovery pressure of the formation in order to avoid cap rock fracture — a sufficiently high threshold pressure is needed to ensure that air will not migrate through pore spaces in the cap rock in response to pressure fluctuations during CAES operation. The parameters of porosity, permeability, and thickness will impact different aspects of CAES operation, including reservoir capacity, compressed air deliverability, and the required operating pressures of the turbo-machinery.

Unlike a salt cavern storage or hard rock cavern, multiple wells are required to accept injection and withdrawal of air delivered by the compressor and required by the CAES plant. For a hypothetical 135 MW CAES plant, 400 lbs/sec or approx 3.0 lbs/sec/MW would be required, based on the deliverability of the reservoir. The

70 Jürgen Kepplinger et al., "Present Trends in Compressed Air Energy and Hydrogen Storage in Germany," SMRI Fall Technical Conference, October 3-4, 2011, at 9 (Figure 3.3). (Exh. APL000051).

number of wells needed and the porosity determine the land use needed to support such a CAES facility. The 270-MW Iowa Storage Energy Project ("ISEP") at Dallas, Iowa, was the first project to investigate and consider a well-defined reservoir structure. After developing several exploratory boreholes, the permeability of the sandstone was determined to be such that injection and withdrawal rates would not support the 800 lbs/sec flow for the planned facility. As a result, only a much smaller CAES project was technically possible. At the reduced size, the project could not be economically justified. As a result, the project was subsequently terminated.[71]

To the best of my knowledge, there are no aquifer storage sites under consideration for CAES in Maryland. Thus, aquifer storage as the medium for CAES in Maryland is very unlikely for the foreseeable future.

Q62. Are there other storage systems for CAES projects that could be used in Maryland?

A62. (SVDL) EPRI and others have performed studies on pipe and pressure vessel storage. For above ground pipe and pressure vessels, there were no major advantages other than the fact that shop-fabricated pressure vessels of 8 to 12 ft diameter had shorter installation times and lower installation costs.

The most cost-effective system would be buried pipeline using transmission right of way and other available space at existing sites. Construction of natural gas pipelines is well-established and 42-inch, 48-inch, or 60-inch welded pipe delivered in 80 ft lengths could be cost effective. For example, a 42" pipe (1515 psia) can store +/-

71 Iowa Store Energy Park Press Release, "Iowa Stored Energy Park Project Terminated," July 28, 2011 (Exh. APL000052).

5.8428 lbs/air in one cubic foot of pipe. One foot length equals 7.817 cubic feet, where as a 60' pipe will store 2.445 times per foot length. Buried pipe CAES projects would probably favor the readily-produced and easily-transportable 42-inch pipe, though the full economics of pipe and installation costs would have to be developed based on current gas pipeline costs. Storing at 1000 psig would increase the required pipe length for the same output by a factor of 1.623.

By using a gas turbine in the 5 MW class, a 15.2 MW CAES plant could be achieved. Using pipe storage capable of storing 27.6 MWh, the CAES plant could deliver 30.4 MW-hours during 2 hours of operation. A larger gas turbine could increase CAES plant size to 18.5 MW. To increase the output beyond 30.4 MWh requires additional air storage volume. Considering the higher costs of large battery systems, an additional 5 hours of storage generally would be considered economic for dispersed storage systems. That said, the economics will always be site-specific and related to local storage costs for buried pipe storage (*e.g.*, cost of using transmission line real estate to accommodate the buried pipe).

To the best of my knowledge, there are currently no pipe-storage systems under development in Maryland.

Q63. Can you please describe some of the potential new CAES technologies under development?

A63. (SVDL) The Intervenors' filings mentioned two companies that are working on CAES technologies (SustainX and General Compression). The CAES technologies at these companies involve two concepts that are still in the early phases of development. Based on publications and presentations at energy storage workshops and conferences, the objective of these companies is to create distributed energy storage systems (similar to battery storage), but at a lower cost (*i.e.*, the goal is to fill the market niche that currently is filled by high-cost battery storage).

SustainX has funding to develop and demonstrate a 1 MW CAES system as a hedge against battery cycle life, cost, and the need to recycle batteries that have reached the end of life. The SustainX system is an isothermal compression and expansion concept. Scaling the technology to larger sizes (*i.e.*, above 2 MW) is theoretically possible, but is unlikely to ever serve the bulk energy storage market due to the limitations on time of storage (*e.g.*, limited to a few hours). The nameplate rating cannot be sustained for long periods and should be best described in MW-hours. Thus, SustainX technology is unlikely to support the bulk energy storage systems needed to generate baseload power, as described in the FEIS.

General Compression has also attracted funding for their near-isothermal compression and expansion system. General Compression's approach would need to rely on cavern-type air storage to compete in the bulk energy storage market. In the General Compression approach, the compressor is motor driven and also serves as the expander when the stored air is released. The concept is to use units of 2 MW ratings and install the units as modular, factory-packaged systems up to the limit of the storage system. High production rates and assembly line construction could yield relatively lower costs. However, these could be offset by increased field labor and interconnects costs, as well as by the costs of storage capacity development. Phillips-Conoco signed a support agreement to deploy the first units; however, the time table was not revealed and system development has been ongoing for several years.

Commercialization of either concept, after satisfactory demonstration of proof of concept and scale up economics, would still be 3 to 5 years away. And, as noted above, the primary limitations on the use of these technologies in bulk energy storage systems are the MWh rating for SustainX (*i.e.*, limited to only a few hours worth of stored energy) and the overall storage requirements for large MW General Compression facilities (*i.e.*, very large number of smaller systems must be used together).

Q64. Are there other energy storage technologies under development?

A64. (SVDL) Conversion of renewable energy, such as wind and solar, to hydrogen is another method that could be used to store energy on a bulk basis. In Germany, where salt caverns are abundant for storage, hydrogen can be blended and piped into natural gas pipe supply systems or used directly for power generation.[72] However, hydrogen generation requires huge offshore wind generation, in addition to storage facilities. As discussed in more detail in Mr. Ratti's testimony, this is not a reasonably foreseeable option in Maryland for the next 10 years or longer.

Bulk storage adiabatic CAES systems are still in the early development phase. Thermal Energy Storage ("TES") could store the heat of compression for use in the expansion cycle, which would then require no fuel usage and would have minimal emissions. However, air storage caverns are still necessary. A conceptual demonstration plant of 200 MW, known as "Adelle," is being contemplated in

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72 Jürgen Kepplinger et al., "Present Trends in Compressed Air Energy and Hydrogen Storage in Germany," SMRI Fall Technical Conference, October 3-4, 2011 (Exh. APL000051).

Germany.[73] However, even if the TES component proves successful in Germany, this technology would have no application in Maryland due to the lack of large volume air storage.

Q65. Please discuss some of the major permitting issues and anticipated timelines for developing CAES projects.

A65. (SVDL) The permitting issues for CAES projects are similar to those for fossil fuel fired plants. The use of natural gas to support a CAES plant would be similar to any gas turbine combined cycle plant in terms of land use footprint and water use. The storage facility itself will have additional permitting requirements, including permits to drill wells in the designated aquifer and disposal of solution-mined brine. These aspects of permitting (without significant public opposition) would take at least three years. Another three years would be needed to purchase, construct, and commission the plant. Smaller pipe storage systems could be realized in approximately five years. However, technical and safety issues related to high pressure buried piping or above ground pipelines could cause permitting delays.

Q66. In your professional opinion, is the use of CAES in combination with wind turbines to generate 1600 MW of continuous base load power to the Maryland grid reasonably foreseeable in the next 10 years or longer?

A66. (SVDL) No. First, large scale storage facilities would need to be explored and developed. Permitting requirements for exploratory reservoir boreholes would be another impediment, as well as the actual field development (assuming suitable aquifers were determined to exist, acreage required was available, and the requisite

73 Chris Bullough et al., "Advanced Adiabatic Compressed Air Energy Storage for the Integration of Wind Energy," Proceedings of the European Wind Energy Conference, November 2004 (Exh. APL000053).

boreholes could be installed to deliver the required airflow to a large CAES power plant). In addition, large wind installed capacity would be required, even optimistically assuming a 40% capacity factor for offshore wind. Of course, you can only recover what you can store on a daily input basis.

Q67. In your professional opinion, is the use of CAES in combination with solar energy to generate 1600 MW of continuous base load power to the Maryland grid reasonably foreseeable in the next 10 years or longer?

A67. (SVDL) No, this is not reasonable foreseeable. CAES can only facilitate bringing solar energy, when available, to a steady state of supply during the day. Otherwise, the required storage volume for continued power supply is huge and, in any event, not available in Maryland.

Q68. In your professional opinion, is the use of CAES in combination with wind turbines to generate 100 MW of continuous base load power to the Maryland grid reasonably foreseeable in the next 10 years? What about 400 MW?

A68. (SVDL) Assuming that storage is available, it could be possible to generate 100 MW(e) of "baseload" wind energy – but only if enough wind energy can be delivered such that sufficient energy could be stored for use. The additional storage would allow the CAES plant to continue to generate 100 MW(e) for continuous baseload when the wind was not blowing.[74] In addition, Technical Paper Presentation IMEC-

74 Septimus van der Linden, "Integrating Wind Turbine Generators (WTGs) with GT-CAES (Compressed Air Energy Storage) stabilizes power delivery with the inherent benefits of Bulk Energy Storage," IMECE 2007-41853, November 2007 (Exh. APL000054); Septimus van der Linden, Technical Paper Presentation, IMECE 2007-41853, "Integrating Wind Turbine Generators (WTGs) with GT-CAES (Compressed Air Energy Storage) stabilizes power delivery with the inherent benefits of Bulk Energy Storage," November 2007 (Exh. APL000026).

41853 graphically illustrates (in slides 51 to 54) wind energy storage issues.[75] However, given the current state of CAES development, this is unlikely to occur in the next decade or two.

For 400 MW(e) the wind resource would need to be close to 1600 MW installed capacity, and in addition to large cavern or reservoir storage facilities.[76] This is unlikely to be available in Maryland for a decade or two. And, of course, this discussion is at best speculative at present, because there are no known geological structures to support CAES in Maryland.

Q69. In your professional opinion, is the use of CAES in combination with solar energy to generate 75 MW of continuous base load power to the Maryland grid reasonably foreseeable in the next 10 years? What about 300 MW?

A69. (SVDL) As with wind energy, this is theoretically possible, but unlikely. In order to produce excess energy for storage, the number of solar arrays would have to be more than double (assuming there is 12 hours of sunshine to support 12 hours of nighttime generation with CAES). And, this does not consider the capital investment and large acreage needed to generate 75 MW(e). The same limitations are applicable to a larger 300 MW(e) facility. So, in my opinion, this is not a reasonable possibility in the next 10 years.

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75 *See* Septimus van der Linden, Technical Paper Presentation, IMECE 2007-41853, "Integrating Wind Turbine Generators (WTGs) with GT-CAES (Compressed Air Energy Storage) stabilizes power delivery with the inherent benefits of Bulk Energy Storage," November 2007 (Exh. APL000026).

76 Ridge Energy Storage & Grid Services L.P., "The Economic Impact of CAES on Wind in TX, OK, and NM, Final Report," Prepared for: Texas State Energy Conservation Office, June 27, 2005 (Exh. APL000012).

F. Assessment of Environmental Impacts of Reasonable Energy Alternatives

Q70. Please summarize the environmental impacts of the combination of energy alternatives.

A70. (DL) As noted above, the environmental impacts associated with the construction and operation of the combination of energy alternatives are SMALL for water use and quality, human health, and environmental justice. The impacts are SMALL to MODERATE for air quality, waste management, and socioeconomics (except taxes and economy). The environmental impacts are MODERATE for land use and ecology and LARGE for historic and cultural resources. The impacts on socioeconomics (taxes and economy) are SMALL to MODERATE beneficial.[77] I agree with the NRC Staff conclusions in the FEIS, which are based, in part, on information presented in the Environmental Report for the COL application.

Q71. Are the NRC Staff's conclusions sensitive to changes in the relative contribution of renewable energy alternatives to the overall combination of alternatives?

A71. (DL) No. Even if wind contribution (with storage) was quadrupled to 400 MW(e) of baseload power, the combination alternative would still require 900 MW(e) from natural gas.[78] While this would proportionally decrease the air emissions associated with the natural gas component of the combination of energy alternatives, it would not change the overall impact categorizations. With a fourfold increase in the contribution of wind, the impact categorizations would not change, except (1) for onshore wind, impacts to land use and ecology might become LARGE; and (2) for offshore wind, increased impacts to aquatic ecology are likely (*i.e.*, could change

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77 FEIS at Table 9-3.

78 FEIS at 9-28.

from MODERATE to MODERATE to LARGE). A combination of alternatives that includes a significant increase in wind production, in conjunction with energy storage, is not clearly preferable to construction of a new baseload nuclear power generating plant located within UniStar's region of interest.

(DL) Even if solar contribution (with storage) was quadrupled to 300 MW(e) of baseload power, with a 300 MW(e) CAES plant, the combination alternative would still require 1000 MW(e) from natural gas. While this would proportionally decrease the air emissions associated with the natural gas component of the combination of energy alternatives, it would not change the overall impact categorizations. With a fourfold increase in the contribution of solar, the impact categorizations would not change except that land use impacts could increase from MODERATE to MODERATE to LARGE due to the low energy density of solar radiation relative to other common energy sources. Even if photovoltaics could be deployed on rooftops and sufficient storage mechanisms were available in conjunction with the photovoltaics to produce baseload power, the environmental impacts of the combination of alternatives still would not change appreciably. A combination of alternatives that includes a significant increase in solar production, in conjunction with energy storage, is not clearly preferable to construction of a new baseload nuclear power generating plant located within UniStar's region of interest.

Q72. As discussed above, the NRC Staff included a sensitivity analysis in the FEIS discussion of a combination of energy alternatives. Is a quadrupling of the contribution of wind or solar to the combination of alternatives reasonable?

A72. (SR) As I explained previously, on balance, assuming that the addition of a storage technology was technically and economically feasible, it is plausible, but unlikely, that 100 MW(e) of “baseload” wind energy could be available in Maryland in the next 10 years. However, an assumption that the amount of baseload-equivalent wind power would be four times that assumed in the FEIS (400 MW versus 100 MW) in the next 10 years is not reasonable.

(SR) With respect to solar, in my professional opinion, installation of the equivalent of 75 MW(e) baseload (assuming that energy storage is technically and economically feasible) is plausible (if unlikely) and therefore reasonable. However, installation of the equivalent of 300 MW(e) of baseload solar (quadruple the amount assumed in the FEIS) in the next 10 years is not a reasonable assumption.

(SR) In addition, if the contribution of wind or solar is assumed to be four times as much as in the FEIS combination, the additional wind or solar likely will displace some of the 100 MW(e) of biomass and the 25 MW(e) of hydropower in the FEIS combination. As a result, the 900 MW(e) or 1000 MW(e) “remaining” contribution from natural gas in the wind and solar sensitivity case is likely under-stated.

(SVDL) A 300 MW CAES plant, in conjunction with solar, or a 400 MW CAES plant, in conjunction with wind, capable of producing power that roughly approximates baseload would be larger than any CAES plant in existence in the world at present. Moreover, no storage media (*e.g.*, salt domes, caverns, deep aquifer) are known to exist in Maryland and, even if they were present, would take many years of development to commission for operation. Thus, an alternative involving a much greater contribution of wind or solar, in conjunction with CAES, is not reasonably foreseeable.

III. CONCLUSIONS

Q73. What are your overall conclusions regarding the reasonableness of the NRC Staff's assumption of 100 MW(e) of wind power, in conjunction with energy storage, as baseload power in the FEIS combination of alternatives?

A73. (SR) On balance, assuming that the addition of a storage technology was technically and economically feasible, it is plausible, but unlikely, that 100 MW(e) of "baseload" wind energy could be available in Maryland in the next 10 years. The use of 100 MW(e) of wind energy in the FEIS is reasonable.

(SVDL) Assuming that sufficient wind energy over and above the 100 MW can be delivered on a continuous basis such that another 100 MW could be stored for use in a CAES plant, it is technologically plausible to create 100 MW of "baseload" wind power. However, given the current state of CAES development and the lack of any known storage resources in Maryland, this is not reasonably foreseeable. Thus, the FEIS combination of energy alternatives is speculative, at least to the extent that it relies on the availability of CAES.

Q74. What are your overall conclusions regarding the reasonableness of the NRC Staff's assumption of 75 MW(e) of solar power, in conjunction with energy storage, as baseload power in the FEIS combination of alternatives?

A74. (SR) As I noted previously, increases in installed solar capacities are likely to be driven by Maryland's RPS. In my professional opinion, installation of the equivalent of 75 MW(e) "baseload" solar (assuming that energy storage is technically and economically feasible) is plausible and therefore reasonable. The use of 75 MW(e) of solar energy in the FEIS is therefore reasonable. However, generation of greater amounts of "baseload" solar is unlikely to occur in the next 10-15 years.

(SVDL) Assuming that enough solar energy can be delivered on a continuous basis such that sufficient energy can be stored in a CAES plant, it is technologically plausible to create 75 MW of "baseload" solar power. However, given the current state of CAES development and the lack of any known storage resources in Maryland, this is very unlikely to occur in the foreseeable future. Thus, the FEIS combination of energy alternatives is speculative, as least to the extent that it relies on the availability of CAES.

Q75. What are your overall conclusions regarding the assessment of energy alternatives in the FEIS?

A75. (DL) I agree with the NRC Staff's conclusions. The combination of energy alternatives considered in the FEIS is reasonable based on based on evaluations of technologically and economically achievable generation technologies in the region of interest. Based on the assessment of the environmental impacts of a range of reasonable energy alternatives, combinations involving wind and solar power with storage, supplemented with natural gas, are not environmentally preferable to Calvert Cliffs 3 — even considering the potential for significant increases in the contributions of wind and solar. Any dispute over the specific mix of wind or solar used in the combination of alternatives is not one that would affect the outcome of the NEPA analysis.

October 21, 2011

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
CALVERT CLIFFS 3 NUCLEAR PROJECT, LLC.	)	
AND UNISTAR NUCLEAR OPERATING	)	Docket No. 52-016
	)	
(Calvert Cliffs 3 Nuclear Project, LLC)	)	
	)	

PREFILED DIRECT TESTIMONY OF ANDREW J. KUGLER AND KATHERINE A. CORT CONCERNING ENVIRONMENTAL CONTENTION 10C

Q1. State your names, occupations, and by whom are you employed.

A1a. [AJK][1] My name is Andrew J. Kugler. I am employed as a Senior Project Manager by the U.S. Nuclear Regulatory Commission's ("NRC") Office of New Reactors, Division of Site and Environmental Review, Environmental Projects Branch 2.[2] I have been employed at the NRC for more than 21 years as a safety project manager (1990 to 2000) and environmental project manager (2000 to present). A statement of my professional qualifications is attached hereto as Exhibit NRC000005.

A1b. [KAC] My name is Katherine A. Cort. I am employed as a Staff Scientist and Economist at Pacific Northwest National Laboratory (PNNL), operated for the U.S. Department of Energy (DOE) by Battelle Memorial Institute. I have been employed at PNNL for 13 years. A statement of my professional qualifications is attached hereto as Exhibit NRC000006.

Q2. Describe your job duties and responsibilities.

[1] In this testimony, the identity of the witness who supports each numbered paragraph is indicated by the notation of his/her initials in parentheses.

[2] Effective December 1, 2011, Andrew Kugler will be employed in the Office of New Reactors, Division of Site Safety and Environmental Analysis, Environmental Technical Support Branch.

A2a. [AJK] I am a senior project manager in Environmental Projects Branch 2, Division of Site and Environmental Reviews, Office of New Reactors. In that role I am responsible for leading environmental review teams. I also provide technical support to other review teams as a technical reviewer. One area in which I have focused over the last few years has been alternatives analyses under NEPA. For the Calvert Cliffs Unit 3 combined license (COL) application environmental review in particular, I am the lead technical reviewer for energy alternatives and alternative sites. In this role I provided technical oversight to the NRC Staff and PNNL reviewers, and provided technical input to the evaluation of energy alternatives. My assessment of energy alternatives is contained in Section 9.2 of NUREG-1936, "Environmental Impact Statement for the Combined License (COL) for the Calvert Cliffs Nuclear Power Plant, Unit 3, Final Report," May 2011 ("FEIS") (Ex. NRC000003A, NRC000003B).

A2b. [KAC] My current responsibilities at PNNL include (1) assisting the NRC Staff with environmental reviews for new nuclear power plant licensing and operating plant license renewals in the areas of socioeconomics, land use, environmental justice, alternative sites, energy alternatives, and benefit-cost analysis including need for power; (2) providing economic, building energy, and environmental analytical support for the DOE's Office of Energy and Renewable Energy (EERE); (3) developing and maintaining models for, and assessment of, the energy impacts of EERE energy efficiency and renewable energy programs; and (4) developing National benefit estimates for EERE's buildings portfolio including metrics for building energy codes, commercial, and residential buildings integration programs.

Q3. Describe your professional qualifications including education, training, work experience, and publications.

A3a. [AJK] I earned a B.S. in Mechanical Engineering from Cooper Union and an M.S. in Technical Management from Johns Hopkins University. I have been employed by NRC from 1990 to the present, working in both the safety (1990 to 2000) and environmental

(2000 to present) arenas. Prior to joining the NRC, I was an engineering group supervisor and an NRC licensed senior reactor operator at River Bend Nuclear Station in Louisiana. Before that I served in the U.S. Navy as an officer in the engineering department of a nuclear submarine.

Addressing my qualifications specific to energy alternatives, I have led or supported teams developing environmental impact statements (EISs) for nuclear power plant license renewal applications (10 projects, of which I was lead for 3), 2 early site permits (ESP; of which I was lead for 1), and COL applications (7 projects, of which I was lead for 1). For all of the new reactor reviews and many of the license renewal reviews, I was directly involved in the preparation of the sections on alternatives, including energy alternatives. I've also completed 7 courses related to National Environmental Policy Act (NEPA) reviews, including Environmental Regulation, and Current and Emerging Issues in Environmental Policy. I attended the Energy and the Environment 2010 Conference, and made presentations regarding environmental reviews and alternatives to national and international audiences. Finally, I authored the 2007 revisions to the Environmental Standard Review Plan (ESRP, NUREG-1555) Introduction, which addresses guidance common to all sections, and the sections for the review of alternatives, including those sections specific to energy alternatives.

A3b. [KAC] I received a B.S. in Economics from Southern Methodist University and a M.A. in Economics from the University of Washington. I have been employed at PNNL from 1998 to the present. I am a scientist on the technical staff of the Energy and Efficiency Division. Prior to my employment with PNNL, I was an economic analyst for the State of Washington conducting economic analyses of legislative and rule changes. Prior to that, I was an economic analyst for the City of Seattle Public Utilities in the water conservation office. I spent one year in San Jose, Costa Rica (1994-1995) as part of a research fellowship examining economic incentives for sustainable land use and watershed management of the Arenal Watershed, working in conjunction with the Tropical Science Center, a non-profit, non-governmental scientific and environmental organization. I have been conducting economic impact studies for more than 15 years, and I have been involved in assessing energy alternatives related to nuclear power plants over the previous 12 years. I have prepared EIS sections on socioeconomics, benefits and costs, need for power, environmental justice, alternatives, and land use for 3 nuclear power plant license renewal and 5 ESP and COL applications.

Q4. Describe your involvement and responsibilities regarding the NRC Staff's preparation of the EIS for the COL for Calvert Cliffs Unit 3.

A4a. [AJK] I became involved in the Calvert Cliffs Unit 3 alternatives review in mid-2008, initially assisting in the review of the site selection process. At the beginning of 2009, I took over as the lead reviewer for alternatives for the environmental review. In this role I provided oversight to our contractor, PNNL, and provided input for the energy alternatives and alternative sites portions of the draft and final EIS.

A4b. [KAC] Prior to my participation in this hearing process, my involvement in the Calvert Cliffs Unit 3 environmental review has been to peer review EIS sections prior to formal publication by the NRC. I have worked closely with the recently retired PNNL staff member previously assigned to the energy alternatives portion of the EIS and have participated in an orderly transition of responsibility for the technical aspects of the review.

Q5. What is the purpose of your testimony?

A5. [AJK, KAC] The purpose of this testimony is to present the NRC Staff's position with regard to Contention 10C. Specifically, we will discuss the process used to develop and evaluate the combination of energy alternatives, present the results of the evaluation of that alternative, and demonstrate its compliance with the requirements of NEPA.

Q6. Are you familiar with Contention 10C?

A6. [AJK, KAC] Yes, we are familiar with Contention 10C. Contention 10C, submitted in this proceeding by intervenors Nuclear Information and Resource Service, Beyond Nuclear, Public Citizen and Southern Maryland Citizens' Alliance for Renewable Energy Solutions (collectively, "Joint Intervenors"), as restated by the Atomic Safety and Licensing Board in its December 28, 2010 Order, alleges that:

> The DEIS [draft environmental impact statement] discussion of a combination of alternatives is inadequate and faulty. By selecting a single alternative that under-represents potential contributions of wind and solar power, the combination alternative depends excessively on the natural gas supplement, thus unnecessarily burdening this alternative with excessive environmental impacts.

Calvert Cliffs 3 Nuclear Project, LLC, and Unistar Nuclear Operating Services, LLC (Combined License Application for Calvert Cliffs Unit 3), LBP-10-24, 72 NRC __, __ (Dec. 28, 2010) (slip op. at 10) (2010 Order). We are also familiar with the Joint Intervenors' related filings, including the Submission of Contention 10 by Joint Intervenors (June 25, 2010); the Submission of Amended Contention 10C by Joint Intervenors (June 20, 2011); and the Atomic Safety and Licensing Board's Memorandum and Order (Denying Summary Judgment of Contention 10C, Denying Amended Contention 10C, and Referring Ruling on Contention 1 (Aug. 26, 2011) (unpublished).

Q7. Did the FEIS's combination of energy alternatives analysis under-represent the contribution of wind and solar power to the combination of energy alternatives and depend excessively on the natural gas component, unnecessarily burdening the alternative with excessive environmental impacts?

A7. [AJK, KAC] No. The approach used to develop a combination of energy alternatives included the maximum contribution from renewable sources that could be reasonably expected within the region of interest and within the timeframe of the proposed project. In doing so, the size of the contribution from natural gas generation was minimized. The approach was based on data from authoritative sources and is consistent with the ESRP.

In the following testimony, we will describe the approach and the regulatory guidance that was employed to determine and evaluate the combination of energy alternatives in the

FEIS. We will provide the sources of information on which the analysis is based and describe how this information was used to develop and evaluate the combination of energy alternatives. We will explain the assumptions used to develop the combination of energy alternatives and specifically describe how the level of contribution from wind power, solar power, and fossil-fired power generation was determined.

Q8. Did you review or rely on any specific documents to prepare your testimony?

A8. [AJK, KAC] Yes. The assessment of energy alternatives, including the combination of energy alternatives, is presented in the FEIS in Section 9.2 (Ex. NRC000003A). In preparing this testimony we have also considered and referenced the following specific documents (with NRC Exhibit numbers as noted) in the responses for which we are individually responsible, as indicated by our initials:

Exhibits

- [AJK] Notice of Availability of Memorandum of Understanding Between U.S. Army Corps of Engineers and U.S. Nuclear Regulatory Commission on Environmental Reviews Related to the Issuance of Authorization to Construct and Operate Nuclear Power Plants, 73 Fed. Reg. 55,546 (Sept. 25, 2008) (Ex. NRC000007).

- [AJK, KAC] Tim Wheeler, *MD's largest solar project under construction*, B'more Green Blog (Sept. 29, 2011), *available at* http://weblogs.baltimoresun.com/features/green/2011/09/mds_largest_solar_project_unde.html (B'moreGreen 2011) (Ex. NRC000039).

- [AJK, KAC] Alison M. Conner & James E. Francfort, Idaho National Engineering and Environmental Laboratory, U.S. Hydropower Resource Assessment for Maryland DOE/ID-10430(MD) (1997) (Conner and Francfort 1997) (Ex. NRC000042).

- [AJK, KAC] *Power Generation: Generation Facilities*, Constellation Energy, http://www.constellation.com/portal/site/constellation/menuitem.24df26f4581930908d84ff10025166a0 (last visited Jan. 7, 2011) (Constellation 2011) (Ex. NRC000026).

- [AJK, KAC] *Roth Rock*, Gestamp Wind, http://www.gestampwind.com/en/business/innovating-projects/roth-rock (last visited Oct. 18, 2011) (Gestamp 2011) (Ex. NRC000025).

- [AJK, KAC] *ConocoPhillips Joins $54.5M Series B for General Compression*, Houston citybizlist (June 7, 2011), http://Houston.citybizlist.com/17/2011/6/7/ConocoPhillips-Joins-54.5B-Series-B-for-General-Compression.aspx (Houstoncitybizlist 2011) (Ex. NRC000041).

- [AJK, KAC] John Hynes, *How to Compare Power Generation Choices*, Renewable Energy World.com (Oct. 29, 2009), http://www.renewableenergyworld.com/rea/news/article/2009/10/how-to-compare-power-generation-choices (Hynes 2009) (Ex. NRC000013).

- [AJK, KAC] Maryland Public Service Commission, Electric Supply Adequacy Report of 2007 (2007), *available at* http://webapp.psc.state.md.us/Intranet/Reports/2007SupplyAdequacyReport_01172007.pdf (MPSC 2007) (Ex. NRC000017).

- [AJK, KAC] Maryland Public Service Commission, Final Report Under Senate Bill 400: Options for Re-Regulation and New Generation (Dec. 16, 2008), *available at* http://webapp.psc.state.md.us/Intranet/sitesearch/MD%20PSC%20Slide%20Presentation_12.16.08_Re%20SB%20400%20Final%20Report.pdf (MPSC 2008b) (Ex. NRC000023).

- [AJK, KAC] Maryland Public Service Commission, In the Matter of the Application of UniStar Nuclear Energy, LLC and UniStar Nuclear Operating Services, LLC for a Certificate of Public Convenience and Necessity to Construct a Nuclear Power Plant at Calvert Cliffs in Calvert County, Maryland, Case Number 9127, Order Number 82741 (June 26, 2009) (MPSC 2009a) (Ex. NRC000014).

- [AJK, KAC] Maryland Public Service Commission, Ten-Year Plan (2008-2017) of Electric Companies in Maryland (2009), *available at* http://webapp.psc.state.md.us/Intranet/psc/Reports_new.cfm (MPSC 2009b) (Ex. NRC000016).

- [AJK, KAC] Maryland Public Service Commission, In the Matter of the Application of UniStar Nuclear Energy, LLC and UniStar Nuclear Operating Services, LLC for a Certificate of Public Convenience and Necessity to Construct a Nuclear Power Plant at Calvert Cliffs in Calvert County, Maryland, Case Number 9127, Proposed Order of Hearing Examiner (Apr. 28, 2009) (MPSC 2009c) (Ex. NRC000015).

- [AJK, KAC] Maryland Public Service Commission, Ten-Year Plan (2009 – 2018) of Electric Companies in Maryland (2010), *available at* http://webapp.psc.state.md.us/Intranet/psc/Reports_new.cfm (MPSC 2010) (Ex. NRC000018).

- [AJK, KAC] Maryland Public Service Commission, Ten-Year Plan (2010 – 2019) of Electric Companies in Maryland (2011), *available at* http://webapp.psc.state.md.us/Intranet/psc/Reports_new.cfm (MPSC 2011) (Ex. NRC000028).

- [AJK, KAC] Walter Musial & Bonnie Ram, National Renewable Energy Laboratory, Large-Scale Offshore Wind Power in the United States; Assessment of Opportunities and Barriers, NREL/TP-500-40745 (2010) (NREL 2010) (Ex. NRC000024).

- [AJK, KAC] ReliabilityFirst Corporation, Long Term Resource Assessment 2009-2018 (2009) (ML100481002) (RFC 2009) (Ex. NRC000019).

- [AJK, KAC] *ReliabilityFirst – About Us*, ReliabilityFirst Corporation, https://rfirst.org/Pages/AboutUs.aspx (last visited Oct. 17, 2011) (RFC 2011) (Ex. NRC000020).

- [AJK, KAC] *Solar Installation at Perdue to be One of East Coast's Largest*, Renewable Energy World.com (Jan. 18, 2011), http://www.renewableenergyworld.com/rea/partner/standard-solar-inc/news/article/2011/01/solarinstallation-at-perdue-to-be-one-of-east-coasts-largest/. (RenewableEnergyWorld.com 2011) (Ex. NRC000037).

- [AJK, KAC] Southern Co. and Georgia Institute of Technology, Southern Winds: Summary Project Report 2007: A Study of Wind Power Generation Potential off the Georgia Coast (2007), *available at* http://www.energy.gatech.edu/research/Summary-Southern-Winds.pdf (Southern and GIT 2007) (Ex. NRC000034).

- [AJK, KAC] Samir Succar & Robert H. Williams, Princeton University: Energy Systems Analysis Group, Compressed Air Energy Storage: Theory, Resources, and Applications for Wind Power (2008), *available at* http://www.princeton.edu/~ssuccar/caesReport.html (Succar and Williams 2008) (Ex. NRC000040).

- [AJK, KAC] Tina Casey, *Baltimore GM Factory Grows with Solar Power*, TriplePundit (May 23, 2011), http://www.triplepundit.com/2011/05/baltimore-gm-solar-power/ (TriplePundit 2011) (Ex. NRC000038).

- [AJK, KAC] UniStar Nuclear Energy, Calvert Cliffs Nuclear Power Plant Unit 3 Combined License Application, Part 1: General Information, Revision 7, Section 1.1.3 (Dec. 20, 2010) (ML103620352) (UniStar 2010) (Ex. NRC000011).

- [AJK] U.S. Department of Energy, Energy Information Administration, An Updated Annual Energy Outlook 2009 Reference Case Reflecting Provisions of the American Recovery and Reinvestment Act and Recent Changes in the Economic Outlook, SR/OIAF/2009-03 (2009), *available at* http://www.eia.doe.gov/oiaf/servicerpt/stimulus/index.html (ML100490743) (DOE/EIA 2009) (Ex. NRC000033).

- [AJK, KAC] U.S. Department of Energy, Energy Information Administration, Annual Energy Outlook 2010, DOE/EIA-0383, Tables A9 and 90 (2010), *available at* http://www.eia.doe.gov/oiaf/archive/aeo10/index.html (ML111170385) (DOE/EIA 2010a) (Ex. NRC000035).

- [AJK, KAC] U.S. Department of Energy, Energy Information Administration, Levelized Cost of New Generation Resources in the Annual Energy Outlook 2011 (2010), *available at* http://205.254.135.24/oiaf/aeo/electricity_generation.html (DOE/EIA 2010b) (Ex. NRC000021).

- [AJK, KAC] *Electricity Terms and Definitions*, U.S. Department of Energy, Energy Information Administration, http://www.eia.gov/cneaf/electricity/page/glossary.html (last visited on Sept. 19, 2011) (DOE/EIA 2011a) (Ex. NRC000012).

- [AJK, KAC] U.S. Department of Energy, Energy Information Administration, Annual Energy Outlook 2011, DOE/EIA-0383, Table 58.9 (2011), available at http://www.eia.gov/oiaf/aeo/tablebrowser/#release=AEO2011&subject=0-AEO2011&table=67-AEO2011&region=3-9&cases=ref2011-d020911a (DOE/EIA 2011b) (Ex. NRC000022).

- [AJK, KAC] U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy, 2008 Solar Technologies Market Report (2010), *available at* http://www1.eere.energy.gov/library/asset_handler.aspx?src=http://www1.eere.energy.gov/solar/pdfs/46025.pdf&id=4129 (DOE/EERE 2010) (Ex. NRC000036).

- [AJK, KAC] U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy, 2010 Wind Technologies Market Report (2011), *available at* http://www1.eere.energy.gov/windandhydro/pdfs/51783.pdf (DOE/EERE 2011) (Ex. NRC000029).

- [AJK, KAC] U.S. Department of Interior, Interior Initiates Process for First "Smart for the Start" Lease for Commercial Wind Power Offshore Delaware: Determines No Competitive Interest for Area Proposed by NRG Bluewater Wind Delaware, LLC (2011), *available at* http://www.doi.gov/news/pressreleases/Interior-Initiates-Process-for-First-Smart-from-the-Start-Lease-for-Commercial-Wind-Power-Offshore-Delaware.cfm (ML110950238) (DOI 2011) (Ex. NRC000027).

- [AJK] U.S. Department of the Interior, Minerals Management Service, Cape Wind Energy Project, Final Environmental Impact Statement (2009), *available at* http://www.boemre.gov/offshore/RenewableEnergy/CapeWindFEIS.htm (MMS 2009) (Ex. NRC000032).

- [AJK] U.S. Nuclear Regulatory Commission, NUREG-1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, Volume 1, Section 8.3.1 & Table 8.1 (1996), *available at* http://www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1437/ (NRC 1996) (Ex. NRC000031).

- [AJK, KAC] U.S. Nuclear Regulatory Commission, NUREG-1555, *Environmental Standard Review Plan -- Standard Review Plans for Environmental Reviews for Nuclear Power Plants*, Rev. 1, Sections 8.4, 9.2.1, 9.2.2, 9.2.3 (2007) (ML071810034, ML071830296, ML071830302, ML071830304) (NRC 2007) (Ex. NRC000008).

- [AJK] U.S. Nuclear Regulatory Commission, Staff Memorandum from Andrew Kugler, Senior Project Manager, to Brent Clayton, RENV Branch Chief, *Supplemental Staff Guidance to NUREG 1555, "Environmental Standard Review Plan," (ESRP) for Alternatives Reviews* (Apr. 26, 2010) (ML100840031) (NRC 2010a) (Ex. NRC000009).

- [AJK, KAC] U.S. Nuclear Regulatory Commission, Staff Memorandum from Jack Cushing, Senior Project Manager, to Brent Clayton, RENV Branch Chief, *Supplemental Staff Guidance for Cumulative Effects Analysis* (Apr. 8, 2010) (ML100990271) (NRC 2010b) (Ex. NRC000010).

- [AJK, KAC] U.S. Nuclear Regulatory Commission, NUREG-1936, *Final Environmental Impact Statement for Combined Licenses (COLs) for Calvert Cliffs Nuclear Power Plant, Unit 3: Final Report*, Volumes 1 and 2 (May 2011) (ML11129A167, ML11129A179) (Ex. NRC000003A, NRC000003B).

- [AJK, KAC] *Cape Wind Energy Project Permit Application Cape Wind Associates, LLC*, U.S. Army Corps of Engineers, http://www.nae.usace.army.mil/projects/ma/capeWind.htm (last visited Oct. 19, 2011) (USACE 2011) (Ex. NRC000030).

Q9. What is the Review Team as referred to in the FEIS?

A9. [AJK] The Review Team is composed of NRC Staff, NRC contractors, and staff from the U.S. Army Corps of Engineers (Corps). FEIS at 4-2 (Ex. NRC000003A). The NRC is the lead agency and the Corps is a cooperating agency on the preparation of the Calvert Cliffs Unit 3 EIS, in accordance with the updated Memorandum of Understanding between the Corps and the NRC. *See* 73 Fed. Reg. 55,546 (Sept. 25, 2008) (Ex. NRC000007). The NRC and the Corps established this cooperative agreement because both agencies have concluded it is the most effective and efficient use of Federal resources in the environmental review of a proposed new nuclear power plant. The goal of this cooperative agreement is the development of EISs for new reactor applications that provide all the environmental information and analyses needed by the NRC to make a license/permit decision and all the information needed by the Corps to make a permit decision. The Corps did not participate in the preparation of this testimony.

<u>OVERVIEW OF THE REVIEW TEAM'S ENERGY ALTERNATIVE ANALYSIS IN THE FEIS</u>

Q10. What is the NRC guidance regarding the review of energy alternatives?

A10. [AJK] The guidance published in the Environmental Standard Review Plan (ESRP) (NUREG-1555), Chapter 9, Sections 9.2.1 through 9.2.3, as modified by a memorandum dated April 26, 2010, provides the basis for the NRC Staff's review of the combination of energy alternatives in an EIS. NRC 2007, 2010a (Ex. NRC000008, NRC000009). As part of this review, the Review Team assesses the environmental impacts of technically feasible and commercially viable energy alternatives available in the region of interest that would be able to meet the purpose and need of the project (NRC 2007) (Ex. NRC000008), and supply the projected demand for electrical energy identified in the need for power analysis in Chapter 8 of the FEIS. (Ex. NRC000003A). The feasibility of offsetting energy supply needs through conservation and other demand-side management measures is also considered as part of the energy alternatives analysis, as are power purchases from other utilities outside the applicant's power system and reactivation or extended plant life within the power system.

Regarding the combination of energy alternatives in particular, ESRP 9.2.2, page 9.2.2-3, states, "[t]he reviewer should review the alternative energy sources and combinations of sources available to the applicant, and categorize them as either competitive or noncompetitive with the proposed project. A competitive alternative is one that is feasible and compares favorably with the proposed project in terms of environmental and health impacts. If the proposed project is intended to supply baseload power, a competitive alternative would also need to be capable of supplying baseload power. A competitive alternative could be composed of combinations of individual alternatives." NRC 2007 (Ex. NRC000008). It also states that, for electrical power generation, "[t]he energy conversion technology should be developed, proven, and available in the relevant region." *Id*. And "[t]he alternative energy source should provide generating capacity substantially equivalent to the capacity need established by the reviewer of ESRP 8.4." *Id*. In addition, ESRP 9.2.2 states that the scope of the review should be directed by regional energy plans from State or regional authorities and by the extent to which the energy sources may be considered as commercially exploitable. *Id*.

Q11. How does the Review Team go about determining which alternative sources of energy could reasonably be expected to meet the demand for additional generating capacity of a proposed project?

A11. [AJK] This analysis is essentially forward looking. The Review Team must consider not only what alternative sources of energy are currently viable and at what levels, but what technologies and capacities will be viable within the timeframe of the proposed action. The NRC Staff used a methodology very similar to that which is used for cumulative impacts analysis to identify those alternative energy projects that are reasonably expected (in the language of ESRP 9.2.2), or reasonably foreseeable (in the language of cumulative impacts analysis). When considering future actions, NRC guidance (adapted from NRC 2010b) (Ex. NRC000010) indicates that the following may fall under the definition of reasonably foreseeable: (1) actions which have been approved by the proper authorities, have submitted license/permit applications, or which may not require approval of a regulating agency, but for which procurement contracts have been signed; (2) actions conditioned upon approval of the project under review. Actions that are not reasonably foreseeable are those that are based on mere speculation or conjecture, or those that have only been discussed on a conceptual basis. Future actions that do not fall under the definition of reasonably foreseeable, but could potentially take place as indicated by trending in the vicinity or less formal communications, may be addressed in a general manner.

While the guidance in NRC 2010b was specifically developed for cumulative impacts analysis, the Staff used this same approach to identify those energy sources that would be included in the evaluation of energy alternatives, consistent with ESRP 9.2.2.

Q12. What was the approach the Review Team used to develop the combination of energy alternatives?

A12. [AJK, KAC] The combination of energy alternatives was developed such that, collectively, the combination of generation and demand-side management strategies could reasonably replace the proposed generation from a 1600 megawatt-electric (MW(e)) baseload plant supplying power to the State of Maryland. There are many possible combinations of alternatives. The Review Team followed the methodology and guidance set out in the ESRP to determine a combination of energy alternatives for baseload power that was technically feasible and commercially viable in the region of interest (Maryland) in the timeframe of the proposed project. NRC 2007 (Ex. NRC000008). The Review Team minimized the environmental impacts of the combination of energy alternatives by including renewable energy sources in amounts that were determined to be achievable within the timeframe of the proposed project. The estimated commercial operations date for Calvert Cliffs Unit 3 used in the FEIS was December 2015.[3] FEIS at 8-1 (Ex. NRC000003A).

Q13. What is a baseload power generation plant?

A13. [AJK, KAC] A "Baseload Plant" as defined by the DOE's Energy Information Administration (DOE/EIA) is one that houses high-efficiency steam-electric units, which are normally operated to take all or part of the minimum load of a system, and which consequently produce electricity at an essentially constant rate and run continuously. These units are operated to maximize system mechanical and thermal efficiency and minimize system operating costs. DOE/EIA 2011a (Ex. NRC000012). Also, "Base load power plants typically have annual load capacity factors that exceed 75%, but usually are more like 90% to 98%. Power plants that fall into this category can be large (400 megawatts (MW) and larger) fossil fueled plants (coal, natural gas or–less often–fuel oil) as well as nuclear plants." Hynes 2009 (Ex. NRC000013).

Q14. What is the capacity factor of a power plant?

A14. [AJK, KAC] The capacity factor is the ratio of the actual energy produced in a given period to the maximum rated output (i.e. running full time). For example, the following

[3] The Staff notes in the "General Information" section of the *Calvert Cliffs Nuclear Power Plant Unit 3 Combined License Application* Revision 7 (UniStar 2010) (Ex. NRC0000011), the applicant states the current projected date for the completion of construction of Unit 3 is December 31, 2017. This 2-year change does not impact the analysis of energy alternatives in the FEIS.

equation would represent the capacity factor for a power plant with a rated capacity of 1,000 MW that produces 648,000 megawatt-hours (MWh) in a 30-day month:

$$\frac{648{,}000\ \text{MW}*\text{hours}}{(30\ \text{days})*\frac{24\text{hours}}{\text{day}}*1000\text{MW}} = 0.90\ \text{(or 90\%)}$$

Q15. How did the Review Team define the purpose and need of the proposed project?

A15. [AJK, KAC] In the case of the Calvert Cliffs Unit 3 application, the purpose and need defined by the Review Team is to provide baseload power generation for the State of Maryland. FEIS at 1-9 (Ex. NRC000003A). The Review Team developed this purpose and need based upon the application and the need for baseload power within the State of Maryland (FEIS at 8-6 to 8-7) (Ex. NRC000003A), as stated by the Maryland Public Service Commission (MPSC) in the Certificate of Public Convenience and Necessity (CPCN) it issued to the applicant on June 26, 2009 (MPSC 2009a) (Ex. NRC000014) affirming the Proposed Order of Hearing Examiner (MPSC 2009c at 52 to 53) (Ex. NRC000015). The Review Team recognizes the MPSC as the expert on the subject of the need for power in Maryland. In the FEIS, the Review Team concluded that the process used by the MPSC in granting the CPCN was systematic, comprehensive, subject to confirmation, and responsive to forecast uncertainty; thus, the process was consistent with the ESRP, and therefore the Review Team gave great weight to the MPSC's conclusions. ESRP 8.4 at 8.4-7 (Ex. NRC000008); FEIS at 8-8 to 8-9 (Ex. NRC000003A).

Q16. Why does the Review Team focus its analysis in the FEIS on energy alternatives on baseload power generation?

A16. [AJK, KAC] As discussed above, for the Calvert Cliffs Unit 3 combined license application, the purpose and need defined by the Review Team is to provide baseload power generation for the State of Maryland. FEIS at 1-9 (Ex. NRC000003A). As stated in ESRP 9.2.2, if the proposed project is intended to supply baseload power, a competitive alternative would also need to be capable of supplying baseload power. NRC 2007 ESRP 9.2.2 at 3 (Ex. NRC000008). As part of this review, the Review Team assessed the environmental impacts of technically feasible and commercially viable energy alternatives that would be available in Maryland, able to meet the purpose and need of the project in the timeframe of the proposed project, and supply part of the projected demand for electrical energy identified in Chapter 8 of the FEIS (Ex. NRC000003A).

Q17. How did the Review Team determine which energy sources would contribute to combination of energy alternatives?

A17. [AJK, KAC] In Section 9.2.3 of the FEIS, the Review Team evaluated alternative energy sources, including oil, wind, solar, hyrdropower, geothermal, wood waste, municipal solid waste, other biomass, and fuel cells. For the combination of energy alternatives, the Review Team considered which of these sources to include and what amount they could contribute. While any number of options and variations is theoretically possible, the Review Team selected those alternative energy sources that are available in Maryland, and at levels of contribution that the Review Team reasonably expects can be achieved to meet the purpose and need of the project within the timeframe of the proposed project. In keeping with NEPA principles, the Review Team established a reasonable combination of energy alternatives to meet the purpose and need for the proposed project that is not inconsistent with energy plans and planning documents for Maryland. See MPSC *Ten-Year Plan (2008-2017) of Electric Companies in Maryland*. MPSC 2009b (Ex. NRC000016) and MPSC *Electric Supply Adequacy Report of 2007*. MPSC 2007 (Ex. NRC000017).

The Review Team concluded that coal and natural gas power plants were feasible alternatives to the proposed project. FEIS Section 9.2.2 (Ex. NRC000003A). In Section 9.2.3 of the FEIS the Review Team evaluated a number of other individual alternatives to the operation of an additional nuclear unit at the proposed site, each of which was insufficient on its own to generate the equivalent of Calvert Cliff Unit 3’s proposed 1600 MW(e) because of the small size of the resource or lack of cost-effective opportunities in Maryland. The value of 1600 MW(e) was used by the Review Team based on the application and the demonstrated need for power in the region of interest (i.e., Maryland) as discussed in Chapter 8 of the FEIS. FEIS at 8-9 to 8-10 (Ex. NRC000003A). The Review Team determined that it was conceivable that a combination of alternatives might be feasible and cost-effective. FEIS at 9-27 (Ex. NRC000003A). Because the only alternatives that were sufficient to individually generate baseload power equivalent to the proposed Calvert Cliffs Unit 3 were fossil-fired generation (i.e., coal-fired and natural gas-fired), which also produce emissions of air pollutants associated with global climate change (e.g., carbon dioxide), the Review Team integrated renewable resources and demand-side management into the combination of energy alternatives, as discussed below.

Q18. How did the Review Team apportion the energy sources within the combination of alternatives?

A18. [AJK, KAC] The apportionment of energy sources within the combination of alternatives is based on data from authoritative sources using an approach that is consistent with the ESRP. The Review Team did not speculate concerning the achievement of theoretical maximums (i.e., converting "potential" into reality) for individual energy technologies. Rather, the Review Team struck a balance between the limited implementation successes for energy technologies such as wind and solar, and the potential of those resources in Maryland. The Review Team relied upon the insights of the DOE, as the agency responsible for energy planning in the U.S., as a reliable source for future predictions and market analyses. To the degree that information unique to the State of Maryland was available, the Review Team adjusted the DOE predictions for renewable energy production upward when it determined that it was appropriate to do so. The resulting combination represents what the Review Team concludes could be reasonably achieved within the region of interest and the timeframe of the proposed project. More detailed discussions of the Review Team's evaluations for wind and solar power are provided below. While it is possible to speculate on different contributions to the combination of alternatives, as discussed below, any combination will include a significant fossil-fuel component with its commensurate environmental impacts. FEIS at 9-28 (NRC000003A).

Q19. Does the Review Team consider “reasonably foreseeable” or “theoretically possible” energy alternatives in its analyses?

A19. [AJK, KAC] The energy alternatives that the Review Team considered are “reasonably foreseeable” as opposed to theoretically possible or maximally possible. The Review Team used the definition of “reasonably foreseeable” that is provided in NRC Staff guidance. NRC 2010b (Ex. NRC000010). The discussion of this methodology as applied to the wind and solar contributions to the combination of energy alternatives is provided in separate subsections below.

Q20. How did the consideration of “reasonably foreseeable” energy alternatives affect the Review Team’s selection of the combination of energy alternatives?

A20. [AJK, KAC] In considering what is likely or reasonable versus what might be theoretically possible, the Review Team recognized that there are a number of energy projects that are conceived or proposed that never come to fruition. Considering, for example, wind power projects in Maryland, the MPSC’s “Ten-Year Plan (2009 – 2018) of Electric Companies in Maryland” (MPSC 2010 (Ex. NRC000018)), updated June 29, 2010, Table III.C.1 illustrates that the MPSC received and approved applications for CPCNs for four onshore wind projects in Maryland. Of these four, two (totaling 120 MW capacity) have been built and are operating. The other two (totaling about 110 MW capacity) have been suspended. In the report, MPSC stated that it does not have any other requests for CPCNs for wind power. This report illustrates two points. First, only half of the wind projects that received CPCNs were built. Second, there is little or no current activity in terms of requests for future wind facilities in Maryland. Similarly, in its *Long Term Resource Assessment 2009 – 2018*, the ReliabilityFirst Corporation (RFC)[4] assigns the Bluewater Wind project in Maryland a "confidence factor" of 21.6% (RFC 2009, page 31, Queue ID T122) (Ex. NRC000019). The confidence factor is used by RFC to estimate the portion of conceptual capacity to include in its planning. The relatively low percentage is an indicator that a high percentage of proposed projects are never completed.

In its June 25, 2010 submission of Contention 10, the Joint Intervenors point to the potential for offshore wind, and to offshore wind projects that have been "proposed and approved that will feed directly into Maryland and the PJM service area." Submission of Contention 10 by Joint Intervenors at 7-8 (June 25, 2010). The Joint Intervenors also specifically refer to the 600 MW(e) Bluewater Wind project that has been proposed off the coast of Maryland.

Based on the NRC Staff guidance, the Review Team did not equate the "potential" of wind energy off the coast of Maryland with a technically feasible and commercially exploitable electric generation resource in the region of interest. "Potential" projects do not provide any power to the grid unless and until they are completed projects. In addition, as will be discussed further below, the Bluewater Wind project off the coast of Maryland has been announced, but has not progressed to the point at which the Review Team considers it to be reasonably foreseeable.

In summary, for the combination of energy alternatives, the Review Team did not use a value for wind energy, or any other energy source in the combination of energy alternatives, based on what was theoretically possible. Rather, the Review Team used a value based on what it determined was reasonably foreseeable in the region of interest and in the timeframe of the proposed project.

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[4] ReliabilityFirst Corporation is one of eight regional electric reliability councils that sets and enforces electric reliability standards. Maryland is in the ReliabilityFirst Corporation territory. RFC 2011 (Ex. NRC000020).

Q21. What was the combination of energy alternatives that was selected and evaluated by the Review Team in the FEIS?

A21. [AJK, KAC] The Review Team developed the following as its combination of energy alternatives for detailed evaluation: 1200 MW(e) of natural gas combined-cycle generating units at the Calvert Cliffs site; 25 MW(e) from hydropower; 75 MW(e) from solar power; 100 MW(e) from biomass sources, including municipal solid waste; 100 MW(e) from conservation and demand-side management programs (beyond what is currently planned); and 100 MW(e) from wind power.

Q22. What were the key assumptions made by the Review Team in selecting and evaluating the combination of energy alternatives in the FEIS?

A22. [AJK, KAC] The combination of energy alternatives was developed based on the following considerations. The wind and solar power contributions would need to be coupled with a storage mechanism such as compressed air energy storage (CAES) to provide baseload power. For wind power, 100 MW(e) equates to at least 250 to 300 MW(e) of installed capacity[5] coupled with a 100 MW(e) CAES plant. The contribution from solar power was determined to be smaller because of the marginal solar power potential for large-scale projects in the Maryland region. FEIS at 9-28 (Ex. NRC000003A). The Review Team developed this combination after researching information from reliable sources such as the DOE/EIA (which is tasked with estimating the future contributions to electrical generation of various sources), DOE/EERE, the National Energy Technology Laboratory (NETL), the National Renewable Energy Laboratory (NREL), and the MPSC. The bases behind key assumptions related to the contributions of wind, solar and natural gas are described in more detail below.

[5] Note that this amount of capacity is based simply on the capacity factor of wind. It ignores the fact that there will be extended periods of low wind that will exhaust the stored energy capacity of the CAES facility, requiring some other source of electrical power to back up the wind/CAES combination.

Q23. Did the Review Team consider the possible ranges of contributions of renewable energy resources to the combination of energy alternatives?

A23. [AJK, KAC] Yes. The Review Team did not begin its review with any preconceived ideas about how much energy each resource could provide to a combination of alternatives. Rather, starting from the information developed for each resource in Section 9.2.3 of the FEIS (Ex. NRC000003A), the Review Team derived contributions of renewable resources to the combination of energy alternatives that it concluded were realistic within the region of interest (Maryland) and within the timeframe of the proposed project. In taking this approach, the Review Team realizes that the actual contributions from renewable sources that develop over the next several years could be higher or lower than those used by the Review Team. But, as discussed above, the Review Team approach used reasonable contributions to the combination of energy alternatives, as NEPA requires.

After developing the contributions of renewable energy resources, the Review Team found that the total of the contributions was significantly less than the 1600 MW(e) baseload generation target. Therefore, the Review Team included a non-renewable source to bring the capacity of the combination of energy alternatives to 1600 MW(e).

Q24. Why does the Review Team's combination of energy alternatives in the FEIS include fossil-fired generation?

A24. [AJK, KAC] Given that the purpose and need as defined by the Review Team is for new baseload generation capacity (FEIS at 1-9) (Ex. NRC000003A), the combination of energy alternatives must be capable of providing baseload generating capacity "substantially equivalent to the capacity need established by the reviewer of ESRP 8.4." NRC 2007 ESRP 9.2.2 at 3 (Ex. NRC000008). A viable alternative to the proposed project must be developed, proven, and available to be placed in service within the timeframe of the proposed project. NRC 2007 ESRP 9.2.2 at 3 to 4 (NRC000008).

In Sections 9.2.2 and 9.2.3 of the FEIS, the Review Team concluded that, besides coal and natural gas-fired generation, the other potential generating sources were not feasible individually as alternatives to the proposed nuclear plant because they could not reasonably be expected to generate baseload power in Maryland in quantities substantially equivalent to, and in the timeframe of, the proposed project. FEIS at 9-20 to 9-27 (Ex. NRC000003A). As discussed above, the total contribution from renewable energy sources in concert with conservation and demand-side management was much less than the 1600 MW(e) baseload target. Therefore, the Review Team concluded that a fossil energy source, most likely coal or natural gas, would need to be a significant contributor to any technically feasible and commercially exploitable combination of energy alternatives to ensure a dispatchable source of baseload generation in the timeframe of the proposed project. The need for a significant contribution to the combination of energy alternatives by a fossil-fueled energy source is supported by the Review Team's evaluation of non-fossil-fueled energy sources (i.e., those other than coal and natural gas) in Section 9.2.3 of the FEIS (Ex. NRC000003A).

Q25. How did the Review Team determine what portion of the energy alternatives combination should be fossil-fired generation?

A25. [AJK, KAC] To determine the magnitude of the fossil-fired contribution to the combination, the Review Team first developed what it determined to be reasonably foreseeable contributions from wind and solar power. The Review Team then did the same to develop contributions from other sources that it determined to be probable contributors: hydropower, biomass (including municipal solid waste), and conservation and demand-side management programs. These added up to a baseload equivalent of 400 MW(e). Having determined the total contribution to the baseload need from renewable sources and conservation/demand-side management, the Review Team allocated the remaining 1200 MW(e) of baseload need to a non-renewable source. Of the two options for this component of the combination of alternatives, coal and natural gas, natural gas would involve less environmental impacts. *See* FEIS Table 9-

4; FEIS at 9-30 (Ex. NRC000003A). Based on this, the Review Team selected a 1200 MW(e) natural gas plant to complete the combination of energy alternatives. This approach yields a combination of energy alternatives with the least environmental impacts overall.

Q26. Does the combination of energy alternatives selected and evaluated by the Review Team depend excessively on natural gas, as alleged by the Intervenors?

A26. [AJK] No. Contention 10C alleges that the combination of alternatives developed by the Review Team "depends excessively on the natural gas supplement, thus unnecessarily burdening this alternative with excessive environmental impacts." 2010 Order at 46. As discussed above, the approach used by the Review Team developed an alternative that included the maximum contribution from renewable sources that would be reasonably foreseeable within the region of interest and within the timeframe of the proposed project. In doing so, the Review Team minimized the size of the contribution from natural gas.

In addition, in the FEIS the Review Team illustrated that another scenario, with the contribution from wind power quadrupled, would not have led to a significant difference in the environmental impacts of the combination of energy alternatives. FEIS at 9-28, 9-30 (Ex. NRC000003A). This scenario, with an installed wind capacity of 1000 to 1200 MW(e), would involve an addition of wind power considerably larger than the proposed Bluewater Wind project off the coast of Maryland. But as previously discussed, the Review Team does not consider the Bluewater Wind project off the coast of Maryland to be reasonably foreseeable at this time.

Q27. What is a merchant plant and does Calvert Cliffs Unit 3's status as a proposed merchant plant impact the evaluation of combination of alternatives?

A27. [AJK, KAC] A merchant plant is an electric generator not owned and operated by an electric utility. It sells its output to wholesale and/or retail customers. Merchant plants may also be called nonutility generators or independent power producers.

Calvert Cliffs Unit 3's status as a proposed merchant plant did not impact the evaluation of the combination of alternatives. The Review Team still focused its review on developing and evaluating a combination of energy alternatives to a 1600 MW(e) baseload electric generating plant that are technically feasible, commercially viable, and available in the region of interest in the timeframe of the proposed project. The Joint Intervenors expressed a concern that, as a merchant plant, there "is no assurance that any electricity from Calvert Cliffs-3, as a merchant power plant, will be sold or used in Maryland." Submission of Contention 10 by Joint Intervenors at 5 (June 25, 2010). However, as stated in the FEIS, Maryland currently imports a significant percentage of its electric power, approximately 30% of its electric power in 2006. FEIS at 8-5 (Ex. NRC000003A). In 2007, the MPSC issued its *Electric Supply Adequacy Report of 2007*. MPSC 2007 (Ex. NRC000017). Among its findings were (1) Maryland cannot meet its own electricity needs from internal resources and has not done so for more than 15 years, and (2) if new generating capacity is not built and/or upgrades to the transmission system are not made, the likelihood of a reliability crisis in Maryland, and eastern PJM Interconnection, LLC, generally, will increase and may become unavoidable. *Id.*; FEIS at 8-6 to 8-7 (Ex. NRC000003A).

Aware that the proposed Calvert Cliffs Unit 3 would be a merchant plant, the MPSC issued its CPCN. Among its conclusions, the MPSC found that (1) Unit 3 would constitute a new large source of power that would be of benefit to the citizens and the State of Maryland, (2) Unit 3 would be a welcome source of baseload power designed to run continuously, which would help peak period congestion on transmission lines within Maryland to the benefit of the public, and (3) Unit 3 would have a positive effect on the reliability and stability of the electric system and would be a beneficial power source for Maryland and the electric grid in general. MPSC 2009a at 2-3 (Ex. NRC000014), affirming the Proposed Order of Hearing Examiner (MPSC 2009c at 52 to 53) (Ex. NRC000015). The Review Team relied upon these findings by the State of Maryland to support the Review Team's use of Maryland as the region of interest for the evaluation of energy alternatives.

EVALUATION OF WIND AND SOLAR POWER

Q28. Are wind and solar generation resources considered baseload resources?

A28. [AJK, KAC] No, they are intermittent resources because the energy available from wind and the sun naturally varies over a wide range at a given location. Thus, wind and solar power plants often produce substantially less than their design output or "capacity," to as little as zero output, for example, when the wind is not blowing for wind power or at night for solar power. The intermittent nature of these renewable resources is the primary reason that they have substantially lower capacity factors than fossil and nuclear baseload generation. In addition, these intermittent resources are not "dispatchable" – that is, you cannot necessarily start them up when you most need them.

Q29. Can an intermittent resource provide baseload generation?

A29. [AJK, KAC] As previously mentioned, baseload power generators are designed to produce electricity at an essentially constant rate and run continuously. An intermittent power source, by itself, would not be able to supply baseload power.

Q30. How did the Review Team address the power generation capacity factors related to large-scale wind and solar powered facilities versus coal or natural gas powered facilities?

A30. [AJK, KAC] In the case of the Calvert Cliffs Unit 3 application, the purpose and need, as defined by the Review Team, is to provide baseload power generation for the State of Maryland. FEIS at 1-9 (Ex. NRC000003A). Baseload power plants typically have annual capacity factors around 80 to 90%, where the capacity factor is the ratio of actual power output over some given period of time and its potential output if it operates at full capacity. Coal-fired generation facilities typically operate with an average annual capacity factor around 85%. DOE/EIA 2010b (Ex. NRC000021). This means that a coal-fired unit rated (i.e., nameplate) at 100 MW capacity would generate approximately 100 MW x 0.85 x 365 days/year x 24 hours/day = 744,600 MWh per year. Wind generation has a lower capacity factor than fossil-based generation, such as coal or natural gas. DOE/EIA reports that newer installations of wind turbines have capacity factors around 34%. DOE/EIA 2010b (Ex. NRC000021). Thus, a wind farm with a generation capacity of 100 MW would generate approximately 100 MW x 0.34 x 365 days/year x 24 hours/day = 297,840 MWh per year. Additionally, as previously mentioned, the megawatt-hour generation from the wind facility is not dispatchable power, as it would not necessarily be available at any given time.

DOE/EIA reports an average capacity factors for solar generation around 18 to 25%. DOE/EIA 2010b (Ex. NRC000021). A 100 MW(e) solar generation facility would generate approximately 100 MW x 0.25 x 365 days/year x 24 hours/day = 219,000 MWh per year, using the 25% capacity factor. As with wind, this power is not dispatchable power. The Review Team considered these corresponding capacity factors when developing the combination of alternatives for baseload generation and in comparing the feasibility of one form of generation to another.

WIND CONTRIBUTION

Q31. What information did the Review Team consider in determining the contribution of wind power generation to the combination of energy alternatives in the FEIS?

A31. [AJK, KAC] Because the Review Team was developing and evaluating a combination energy alternative that would need to be operational by approximately 2015, the Review Team relied on shorter-term projections from reliable sources to inform its evaluation. In its Annual Energy Outlook 2011 (DOE/EIA 2011b; NRC000022), DOE/EIA provides an estimate of the growth in onshore and offshore wind capacity in the ReliabilityFirst Corporation/East region (which includes New Jersey, Delaware, and most of Maryland and Pennsylvania). In addition, the Review Team relied on information from the MPSC (MPSC 2008b, 2009b (Ex. NRC000023, NRC000016)) as well the NREL report (Ex. NRC000024), which considers the offshore wind energy potential throughout the United States, as well as proposed U.S. offshore wind projects and capacities.

Q32. How did the Review Team consider Maryland's wind development potential in the FEIS?

A32. [AJK, KAC] ESRP 9.2.2 states that the scope of the review should be directed by regional energy plans from State or regional authorities and by the extent to which the energy sources may be considered as commercially exploitable. Ex. NRC000008. As previously indicated, the Review Team relied on reliable sources of information to inform its review. In addition to Federal sources (such as the DOE and its National Laboratories), the Review Team also considered information unique to the State of Maryland. The MPSC considered the potential for wind power in Maryland in a 2008 report (MPSC 2008b (Ex. NRC000023)) and concluded the economic benefits from renewables remain uncertain and challenging. Onshore wind yields net economic benefits, albeit on a small scale. Offshore wind, as modeled in the report, does not yield economic benefits. FEIS at 9-20 (Ex. NRC000003A).

There is utility-scale wind energy in Maryland; but there are only two moderate-sized projects (50 and 70 MW), and they are both onshore projects. Gestamp 2011 (Ex. NRC000025); Constellation 2010 (Ex. NRC000026). No Maryland wind projects are approved for offshore locations. The first of the two operating wind projects in Maryland, the 70 MW Criterion onshore wind project, went online in December 2010. Constellation 2010 (Ex. NRC000026). The other, the 50 MW onshore Roth Rock project, went online in July 2011. Gestamp 2011 (Ex. NRC000025). The NRG Bluewater Wind project off the nearby Delaware coast in Federal waters is currently planned to have a capacity of 450 MW(e), of which 293 MW(e) has been allocated to power purchase agreements. DOI [U.S. Department of Interior] 2011 (Ex. NRC000027). The project would be located approximately 11 miles east of Dewey Beach, Delaware. *Id*. NREL did not identify any other wind energy projects off the coast of Maryland or adjoining States (Delaware and Virginia) in either State or Federal waters that it considered sufficiently advanced to include in its report. *See* FEIS at 9-23 (Ex. NRC000003A).

According to the MPSC "Ten-Year Plan (2009 – 2018) of Electric Companies in Maryland" (MPSC 2010 (Ex. NRC000010)), there are no other active wind projects in Maryland of which MPSC is aware.[6] Based on this information, the Review Team concluded that significant development of wind generation in Maryland is not likely in the timeframe of the proposed project.

Q33. In addition to its review of Maryland's overall potential for wind development, did the Review Team consider Maryland's offshore wind potential in particular?

A33. [AJK, KAC] Yes. The Review Team primarily relied on NREL's 2010 report (Ex. NRC000024) related to large-scale offshore wind in the United States to assess the offshore wind potential in Maryland. The Mid-Atlantic Region (New Jersey to North Carolina) has up to 570 GW of potential offshore wind capacity (page 59, Table 4-2). About 54 GW (less than 10%) is attributable to Maryland, 15 GW (about 3%) to Delaware, and 94 GW (about 16%) to Virginia (pages 60 – 63, Table 4-3). However, the NREL report (Ex. NRC000024) lists only one offshore wind project, NRG Bluewater Wind, Delaware, in the Delaware/Maryland/Virginia area. The report states (pages 30 – 31, Table 3-3), "[a]lthough many more proposals have been made, the projects listed in the table are more advanced, meeting one or more of the following criteria: they have been approved by their state, received an interim lease from BOEM [Bureau of Ocean Energy Management] (2010), or granted a BOEM lease." Another DOE report, DOE/EERE 2011 (Ex. NRC000029), contains similar information, with minor adjustments that do not affect the key information or conclusions drawn from the report.

The Joint Intervenors expressed a concern that the Review Team had not included the Bluewater Wind project off the coast of Maryland in the FEIS. Submission of Amended Contention 10C by Joint Intervenors at 4 (June 20, 2011). The Bluewater Wind project off the

[6] MPSC has updated its ten-year plan. The MPSC "Ten-Year Plan (2010 – 2019) of Electric Companies in Maryland" is consistent with the Review Team's conclusions. MPSC 2011 (Ex. NRC000028).

coast of Maryland is a different project from the NRG Bluewater Wind project off the coast of Delaware listed in the NREL report. The NREL report does not include the Bluewater Wind project in Maryland in the list of projects that have sufficiently advanced because that project has not made any significant progress in the leasing/permitting process. The Review Team did not include this project in the FEIS because, based on the project's status, it is not reasonably foreseeable. As a point of reference, the Cape Wind Project off the coast of Cape Cod, Massachusetts, has been engaged in the leasing/permitting process for over a decade, and has yet to be constructed. Corps 2011 (Ex. NRC000030). Therefore, it is unlikely that a project such as the Bluewater Wind project in Maryland, which has not made any significant progress in the leasing/permitting process, could be operational within the timeframe of the proposed project.

The Review Team reviewed the Wind Technologies Market Report (DOE/EERE 2011 (Ex. NRC000029)), which found, consistent with the 2010 NREL report, that:

> To date, no offshore projects have been installed in the United States, and the emergence of a U.S. offshore wind power market still faces many challenges. Perhaps most importantly, the projected near-term costs of offshore wind energy remain high. Additionally, though political support exists for offshore wind energy in some quarters, planning, siting, and permitting can be challenging, as demonstrated in the long history of the Cape Wind project. Competing uses of offshore waters and public concerns can complicate the process and, despite recent progress in clarifying the permitting procedures in federal waters, uncertainties in federal and state permitting processes remain.

Id. at 10. The MPSC considered the potential for wind power in Maryland in a 2008 report. MPSC 2008b (Ex. NRC000023). Offshore wind, as modeled in the report, does not yield economic benefits. Because of this, development of wind power off the coast of Maryland is unlikely without subsidies or other incentives. Based on this information, the Review Team concluded that offshore wind would not significantly contribute to the combination of energy alternatives in the timeframe of the proposed project.

Q34. How did the Review Team derive the 100 MW(e) wind power contribution to the combination of energy alternatives.?

A34. [AJK, KAC]: As previously mentioned, the Review Team primarily relied on U.S. DOE's Annual Energy Outlook (DOE/EIA 2011b (NRC000022), NREL's 2010 report (Ex. NRC000024) related to large-scale offshore wind in the United States, and MPSC's Ten-Year Plan (MPSC 2009b) (Ex. NRC000016) to determine the likely contribution of wind power to the combination energy alternative. For the RFC/East region, DOE/EIA projects a growth of 420 MW of onshore wind capacity and 200 MW of offshore wind capacity between 2010 and 2035. DOE/EIA 2011b (Ex. NRC000022). If Maryland is conservatively assumed to account for a third of this growth, that would equate to about 210 MW(e). Using 34% for the capacity factor of wind, the 210 MW of capacity equates to about 71 MW of baseload capacity. The Review Team value of 100 MW in the combination of energy alternatives is reasonable in comparison to the DOE/EIA projection. While the data from DOE/EIA are projections, based on the limited wind development in Maryland, the Review Team concluded it would be unreasonable to expect large-scale development of this resource within the timeframe of the proposed project.

Therefore, considering all of this information, the Review Team determined that significant growth in wind energy in Maryland is unlikely within the timeframe of the proposed project. In the combination of energy alternatives, the Review Team assumed the addition of wind generation equivalent to 100 MW(e) of baseload power. For wind power, 100 MW(e) equates to at least 250 to 300 MW(e) of installed capacity coupled with a 100 MW(e) CAES plant. FEIS at 9-28 (Ex. NRC000003A). The Review Team recognizes that the actual growth in wind energy in Maryland could be greater than, or less than, this value. But the Review Team concluded that the selected value represents an optimistic, but achievable, level of wind generation capacity in the region of interest within the timeframe of the proposed project. As such, this is an appropriate value for this NEPA evaluation.

Q35. How does the Review Team respond to the Joint Intervenors' assertion that the FEIS underestimates the wind contribution as part of the combination energy alternatives?

A35. [AJK] The Joint Intervenors have stated that the contribution of wind energy to the combination of energy alternatives "is grossly underestimated in the DEIS' arbitrary formulation." Submission of Contention 10 by Joint Intervenors at 9 (June 25, 2010). However, the Joint Intervenors appear to have focused on the potential for wind as opposed to reasonably foreseeable development. Such a focus is not in accordance with NEPA or NRC Staff guidance, both of which focus on what is reasonable. In addition, as previously discussed, the formulation of the combination of energy alternatives was not arbitrary, but based on projections from reputable sources and the Review Team's technical judgment of reasonable energy development in the area of interest within the timeframe of the proposed project.

The Review Team considered the Joint Intervenors' comments on the DEIS, which stated that the Review Team had underestimated the contribution of wind energy to the combination of alternatives, and determined that these comments warranted additional discussion of the wind contribution in the combination of energy alternatives in the FEIS. FEIS at 9-28, 9-30, Appendix E at E-82 to E-83. (Ex. NRC000003A and NRC000003B). The Review Team also included in the FEIS a scenario in which it quadrupled the amount of wind power generation coupled with storage. In this scenario, the wind power contribution to the combination of alternatives would be 400 MW(e) of baseload power, equivalent to an installed capacity of at least 1000 (offshore) to 1200 (onshore) MW(e) with a 400 MW(e) CAES plant. This scenario would still require 900 MW(e) from natural gas. A 900 MW(e) natural gas-fired plant would still contribute significant emissions (i.e., 3.2 million tons/yr CO_2, 208 tons/yr NO_X, and 63 tons/yr $SO_{X,}$ scaled from FEIS Section 9.2.4 (Ex. NRC000003A)) to this scenario, enough that the Review Team would still conclude that the impacts to air quality would be SMALL to MODERATE.

If an onshore wind farm is used with 2.5 MW turbines, roughly 480 wind turbines would be required covering a land area of approximately 60,000 acres to generate 400 MW(e) baseload equivalent. NRC 1996 (Ex. NRC000031). If an offshore wind farm is used with 5 MW turbines, roughly 200 turbines would be required. The 454 MW Cape Wind Project covers approximately 25 square miles (MMS [U.S. Department of Interior, Minerals Management Service (now the Bureau of Ocean Energy Management and the Bureau of Safety and Environmental Enforcement] 2009) (Ex. NRC000032). Therefore, a 1000 MW offshore wind project would cover approximately 55 square miles. The CAES plant in this scenario would be larger than any such facility worldwide and offshore wind capacity of this magnitude exceeds by a factor of five or more the amount of offshore wind projected by DOE/EIA for the entire United States by the year 2030. DOE/EIA 2009[7] (Ex. NRC000033). Under this scenario, the impact category levels presented in Table 9-3 of the FEIS (FEIS at 9-29) (Ex. NRC000003A) would not change, except that if the project was onshore, the impacts to land use and terrestrial ecology might become LARGE because of the significant land area that would be used for the wind turbines. If the project was offshore, then increased impacts to aquatic ecology, aesthetics and recreation (as a minimum) would occur from the building and operation of the turbines. Based on the lack of mature proposals for onshore or offshore wind in Maryland (as discussed in other responses above), this scenario could not be implemented in the timeframe for the proposed project, and it is therefore not a reasonable alternative to the proposed action. As described above, the environmental impacts of this scenario would also be greater than the impacts of the proposed action, so this scenario would not be environmentally preferable. FEIS at 9-28, 30 (Ex. NRC000003A). The impacts would also be greater than those of the Review Team's combination of energy alternatives.

Q36. Why did the Review Team not quantify the environmental impacts of the scenario in which the contribution of wind to the combination of energy alternatives was quadrupled?

A36. [AJK] The discussion in the FEIS regarding this scenario was included to frame the range of the Review Team's consideration and to provide the decision makers with additional insights. As such, the Review Team did not quantify the impacts of this scenario

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[7] The Review Team found that the DOE/EIA projection for offshore wind power has not changed in the Annual Energy Outlook 2011. DOE/EIA 2011b (Ex. NRC000022).

because it is not part of the combination of energy alternatives that is considered technically feasible and commercially viable in the region of interest within the timeframe of the proposed project, consistent with ESRP 9.2.2. In addition, the Review Team concluded in the FEIS that such a scenario would not be environmentally preferable to the proposed action. FEIS at 9-30 (Ex. NRC000003A).

Q37. Did the Review Team use the Southern Company/Georgia Institute of Technology report to estimate the wind energy potential for Maryland, as alleged by the Joint Intervenors?

A37. [AJK, KAC] No, the Review Team did not use the subject report (Southern and GIT 2007) (Ex. NRC000034) to estimate the wind energy potential for Maryland.

As stated in the FEIS, the Review Team used the report for information related to project costs, the ability of wind turbines to withstand hurricanes, and the Federal regulatory authority related to offshore wind farms. The Review Team maintains that its position as stated in the FEIS, that the conclusions in the subject report related to these issues "would generally apply to a wind farm located offshore of Maryland based on the similarities in the physical and regulatory environments," is correct. This statement in the FEIS has apparently been misunderstood by the Joint Intervenors to mean that the Review Team considers the wind resource and utility regulatory environments in Maryland and Georgia to be similar. This is incorrect. The Review Team drew no such conclusion, and believes that the FEIS clearly articulates that this is not the case. The Joint Intervenors state that the offshore wind potential in Maryland is roughly seven times that of Georgia. The Review Team did not evaluate the offshore wind potential in Georgia, nor compare it to Maryland. Such a comparison is not relevant to the team's analysis because the Review Team's analysis specifically addressed wind resources in Maryland. The Review Team used regionally appropriate data for Maryland from NREL 2010 to estimate Maryland's wind potential. *See* NREL 2010 (Ex. NRC000024).

SOLAR CONTRIBUTION

Q38. What information did the Review Team consider in determining the contribution of solar power to the combination of energy alternatives in the FEIS?

A38. [AJK, KAC] Because the Review Team was developing and evaluating a combination energy alternative that would need to be operational by approximately 2015, the Review Team relied on shorter-term projections from reliable sources to inform the evaluation. The Review Team primarily relied on DOE's Annual Energy Outlook (DOE/EIA 2011b (NRC000022)) and MPSC's Ten-Year Plan (MPSC 2009b (Ex. NRC000016)) to determine the likely contribution of solar power to the combination energy alternative.

Q39. How did the Review Team address Maryland's solar power development potential in the FEIS?

A39. [AJK, KAC] ESRP 9.2.2 states that the scope of the review should be directed by regional energy plans from State or regional authorities and by the extent to which the energy sources may be considered as commercially exploitable. As previously indicated, the Review Team relied on reliable sources of information to inform its review. In addition to Federal sources (such as the DOE and its National laboratories), the Review Team also considered information unique to the State of Maryland. The MPSC considered the potential for solar power in Maryland in a 2008 report (MPSC 2008b (Ex. NRC000023)) and concluded the economic benefits from renewable sources remain uncertain and challenging. For solar energy, the MPSC concluded that the overall economics of solar remain negative, but could improve if technology progresses much faster than contemplated in the report and various financial incentives continue over the long term.

In addition, DOE/EIA does not project the addition of any utility-scale solar thermal or solar photovoltaic power, and limited additions of end-use (i.e., onsite distributed) solar photovoltaic power in the Mid-Atlantic Area Council (now RFC/East, which includes Maryland) through the year 2035. DOE/EIA 2010a, Table 90 (Ex. NRC000035); FEIS at 9-24 (NRC000003A).

Q40. Did the Review Team consider the potential of end-use (i.e., onsite) distributed solar photovoltaic (or PV) power in its combination of energy alternatives?

A40. [AJK, KAC] Yes. Energy from solar power is available in every part of the country. When the Review Team considered how much solar energy was appropriate to be included in the combination of energy alternatives, it had to consider the likelihood that there would be additions of solar photovoltaic generating capacity in Maryland not only at the utility-scale, but also at the end-use level. Both DOE/EIA (DOE/EIA 2010a, Table 90 (Ex. NRC000035)) and MPSC (MPSC 2008b (Ex. NRC000023)) indicate that any significant development of utility-scale solar power is unlikely in the region of interest; however, DOE/EIA does show some growth in end-use generation. MPSC tempers its conclusion by indicating that if technological advances occur faster than contemplated, the economics of solar power could improve to the point that it would be more cost-effective.

Q41. Why is the solar contribution in the combination of energy alternatives not larger if DOE identifies its potential as "Good"?

A41. [AJK, KAC] The solar potential used in the FEIS was based on regional characteristics and the projections of DOE/EIA and MPSC's ten-year plan. DOE/EIA 2010a, Table 90 (Ex. NRC000035)); MPSC 2009b (Ex. NRC000016). The DOE/EERE 2008 Solar Technologies Market Report, Figure 5.5, page 111, indicates that Maryland has a "Good" solar resource potential on a scale that categorizes solar potential as "Moderate," "Good," "Very Good," or "Excellent." DOE/EERE 2010 (Ex. NRC000036). Placing this into context, the Review Team notes that only Alaska and the northwest corner of Washington State are rated less favorably ("Moderate") than Maryland; and well over half the area of the contiguous United States is rated "Very Good" or "Excellent." *Id*. The rating of "Good" for Maryland does not indicate that solar power will be a significant contributor to generating capacity in the State. As discussed below, the Review Team determined that the use of DOE/EIA projections was an appropriate source to establish the contribution of solar energy to the combination of energy alternatives.

Q42. How did the Review Team derive the 75 MW solar power contribution to the combination of energy alternatives in the FEIS?

A42. [AJK, KAC] Although DOE and regional sources suggest the solar potential in Maryland is relatively low, because generation from solar is possible and currently available in Maryland, the Review Team integrated a solar power contribution into the combination of energy alternatives to help offset the impacts of the fossil-fueled portion of the alternative. The 75 MW(e) level of contribution was based on DOE/EIA's overall prediction of growth in solar as an end-use generation source and the Review Team's technical judgment of this prediction as authoritative and reasonable. The Review Team assumed that this solar capacity would be coupled with a 75 MW(e) CAES plant. FEIS at 9-28 (Ex. NRC000003A).

DOE/EIA predicts 0 MW for utility solar capacity between 2010 and 2035 in the RFC/East region, and the addition of 810 MW of end-use solar capacity (all photo-voltaic, or PV) in that region over the same period. DOE/EIA 2011b (Ex. NRC000022). End-use facilities are typically of small size because they are only designed to meet a specific local need.

Assuming that Maryland accounts for roughly a third of the RFC/East region, additions of end-use solar capacity in Maryland by 2035 would be about 270 MW. According to DOE/EIA, an average PV capacity factor ranges from 18 to 25% in the U.S. DOE/EIA 2010b (Ex. NRC000021). Using 25% for simplicity, the 270 MW of capacity equates to about 68 MW of baseload capacity. Typical solar-to-electric power plants require 5 to 10 acres for every MW of generating capacity. FEIS at 9-23 (Ex. NRC000003A). Using this number, the 270 MW (75 MW(e) baseload equivalent) solar contribution would impact 1350 to 2700 acres of land and associated terrestrial resources. A larger solar contribution would impact a correspondingly larger land area.

The Review Team concluded that a value of 75 MW in the combination of energy alternatives is reasonable in comparison to the DOE/EIA projection and the MPSC ten-year plan.

Q43. Do the announced solar projects in Maryland, or any that were identified by the Joint Intervenors, conflict with the Review Team's combination of energy alternatives?

A43. [AJK, KAC] No. The Joint Intervenors identified two solar projects that have recently been announced in Maryland: a 3.7 MW solar facility to power two Perdue Farms facilities and a 1.2 MW project to power a new plant making batteries in Baltimore for the Chevrolet Volt automobile. Submission of Amended Contention 10C by Joint Intervenors at 10 (June 20, 2011); RenewableEnergyWorld.com 2011 (Ex. NRC000037); TriplePundit 2011 (Ex. NRC000038). The Perdue Farms solar project is, in fact, two projects, with more than half of the capacity installed at a Perdue facility in Delaware, and the rest at the Perdue Farms headquarters in Maryland. In addition, the output of the facilities is expected to average 3700 MWh per year. Using a 25% capacity factor, this would yield a total capacity for the two projects of 1.7 MW, not 3.7. RenewableEnergyWorld.com 2011 (Ex. NRC000037). The Review Team notes that these two projects have a combined (and intermittent) output of less than 3 MW. Other larger solar power projects (16.1 MW(e) and 20 MW(e), respectively) have been announced in Maryland recently. B'moreGreen 2011 (Ex. NRC000039). These announcements are not inconsistent with the Review Team's analysis and findings which assume the addition of 270 MW of end-user solar power capacity. Most of that growth was expected to occur in the near-term according to DOE/EIA. DOE/EIA 2011b (Ex. NRC000022). Using the same assumption that Maryland accounts for roughly one third of the growth in the RFC/East region, DOE/EIA expected the addition of roughly 60 MW(e) of solar PV generation capacity in 2011 and 2012. These additions of roughly 40 MW(e) of capacity are consistent with that prediction.

ENERGY STORAGE

Q44. What is energy storage and how is it used with electric power generation?

A44. [AJK, KAC] Energy storage is accomplished by devices or physical media that store some form of energy to perform some useful operation, such as electricity generation, at a later time. Energy storage, such as battery storage, CAES, or a pumped storage facility can be coupled with intermittent power sources to simulate a power generation profile comparable to baseload generation.

Q45. What is a CAES facility?

A45. [AJK, KAC] A CAES facility can take power provided by a generation source, such as a wind turbine, and provide the power to compress the air into a storage volume, such as an underground salt cavern or aquifer. In the two existing commercial CAES systems (globally), the compressed air is discharged from the storage volume into a set of gas turbines that are fired with natural gas. The efficiency of the turbines is improved because compression of the inlet air is provided by the CAES facility instead of by the turbine itself. The only operating CAES system in the United States is at the McIntosh Power Plant in Alabama. The CAES system has a capacity of 110 MW(e). Succar and Williams 2008 (Ex. NRC000040). The Review Team is aware of a conceptual design for a CAES system that does not use combustion turbines. However, this design has not been built, tested, or proven. A pilot project for the design is being built in Texas. Houstoncitybizlist 2011 (Ex. NRC000041).

Q46. How did the Review Team consider energy storage for wind and solar in the combination of alternatives in the FEIS?

A46. [AJK, KAC] As discussed in Sections 9.2.3.2, Wind Power, and 9.2.3.3, Solar Power, in the FEIS (Ex. NRC000003A), wind or solar power "in conjunction with energy storage mechanisms such as pumped hydroelectric or CAES, or another readily dispatchable power source, such as hydropower, might serve as a means of providing baseload power." As stated in Section 9.2.3.2 of the FEIS, a pumped storage or other hydroelectric facility is highly unlikely based on the DOE/EIA projection (DOE/EIA 2010a, Table A9 (Ex. NRC000035)) for pumped storage and the low potential for new hydroelectric development in Maryland. Conner and Francfort 1997 (Ex. NRC000047). For the combination of energy alternatives, the Review Team assumed that the wind and solar contributions would need to be coupled with a storage mechanism such as CAES to provide baseload power. FEIS at 9-28 (Ex. NRC000003A).

Regarding CAES, as discussed in Section 9.2.3.2 of the FEIS (Ex. NRC000003A), to date one facility was built in 1978 (290 MW, in Germany) and another in 1991 (110 MW, in Alabama). There is a current proposal for a 268 MW CAES plant coupled to a wind farm in Iowa, and some other proposals in various stages of development in the U.S. None of the proposals is for a facility in Maryland, and it is unclear that such a facility could be sited in the State of Maryland (i.e., that appropriate geological formations exist in the State). The Joint Intervenors point to companies that are working to develop new CAES technologies. These systems are neither developed nor proven. The Joint Intervenors state that these demonstrations "can be increased [in size] quickly before Calvert Cliffs Unit 3 becomes operational." But this statement is speculative, and the Joint Intervenors do not provide any relevant support for this conclusion. In addition, the Review Team found no evidence that any company has made any proposal for a CAES facility in Maryland. ESRP 9.2.2 (NRC 2007) (Ex. NRC000008) states that the "energy conversion technology should be developed, proven, and available in the relevant region." The demonstration systems referred to by the Joint Intervenors meet none of these criteria.

Although there are no plans for CAES facilities in Maryland, the Review Team included some CAES in the combination of energy alternatives in order to include the contributions of wind and solar power in an alternative to the proposed baseload project. However, the Review Team concluded that including a CAES facility in Maryland that is sufficiently large that it would significantly reduce the air emissions impacts of the combination of energy alternatives is speculative, and not within the reasonable range of alternatives based on the history, current state, and projected future potential of CAES development. FEIS at 9-21 (Ex. NRC000003A). Therefore, such a facility was not included in the Review Team's NEPA analysis.

CONCLUSION

Q47. Did the Review Team identify any energy alternatives or combination of energy alternatives that would be environmentally preferable to the proposed action?

A47. [AJK, KAC] No. None of the alternatives capable of meeting the purpose and need of the project in the region of interest and in the timeframe of the proposed project were environmentally preferable to the proposed project. FEIS at 9-31 (Ex. NRC000003A).

Q48. Is the combination of energy alternatives presented in the FEIS unnecessarily burdened with excessive environmental impacts due to an under-representation of wind and solar power and excessive reliance on natural gas, as alleged by the Joint Intervenors?

A48. [AJK] No. As discussed above, the approach used by the Review Team developed an alternative that included the maximum contribution from renewable sources that would be reasonably foreseeable within the region of interest and within the timeframe of the proposed project. In doing so, the Review Team minimized the size of the contribution from natural gas generation. As mentioned above, in the discussion of wind potential, based on the limited wind development in Maryland, the Review Team concluded that it would be unreasonable to expect large-scale development of this resource in the timeframe of the proposed project. In the combination of energy alternatives, the Review Team assumed the addition of wind generation equivalent to 100 MW(e) of baseload power. For wind power, 100 MW(e) equates to at least 250 to 300 MW(e) of installed capacity coupled with a 100 MW(e) CAES plant. FEIS at 9-28 (Ex. NRC000003A). The selection of 100 MW(e) of wind capacity for the alternative energy combination reflects the Review Team's discussion in Section 9.2.3.2 of the FEIS. Sections 9.2.3.2 and 9.2.4 of the FEIS are the basis for the NRC Staff's testimony that 100 MW(e) of wind power is reasonable and a representative value for the wind power contribution to the combination of energy alternatives considering the development of wind generation in the region to date and the potential development of this resource in the region in the timeframe of the proposed project.

The Review Team also considered a scenario in which the wind contribution was quadrupled to 400 MW(e) of baseload power, equivalent to an installed capacity of at least 1000 to 1200 MW(e) with a 400 MW(e) CAES plant. Under this scenario, the combination of energy alternatives would still require 900 MW(e) from a natural gas-fired plant in order to meet the target generation capacity of 1600 MW(e), as discussed above. The CAES plant in this scenario would be larger than any such facility worldwide and offshore wind capacity of this magnitude exceeds by a factor of five or more the amount of offshore wind capacity projected by DOE/EIA for the entire United States by the year 2030 (DOE/EIA 2009 (Ex. NRC000033)). Under this scenario, the impact categorizations in Table 9-3 in the FEIS (Ex. NRC000003A) would not change, except that impacts to land use and terrestrial ecology might become LARGE if onshore wind energy is used. If offshore wind is the energy source, then increased impacts to aquatic ecology, aesthetics and recreation (as a minimum) would occur from the building and operation of the turbines. Based on the limited proposals for onshore and offshore wind in Maryland, this scenario could not be implemented in the timeframe for the proposed project. As described above, the environmental impacts of this scenario would still be greater than the impacts of the proposed action, so this scenario would not be environmentally preferable.

When the Review Team considered the contribution of solar power included in the combination of energy alternatives, it had to consider the likelihood that there would be additions of solar generating capacity in Maryland. Both DOE/EIA 2010a, Table 90 (Ex. NRC000021) and MPSC 2008b (Ex. NRC000023) indicate that any significant development is unlikely. Nevertheless, because generation from solar is possible in Maryland, because DOE/EIA is predicting growth in solar as an end-use generation source, and to offset some of the impacts of the fossil-fueled portion of the combination of energy alternatives, the Review

Team concluded that a contribution of 75 MW(e) of solar generation in the combination of energy alternatives was reasonable. Sections 9.2.3.3 and 9.2.4 of the FEIS (Ex. NRC000003A) provide the basis for the NRC Staff's testimony for the selection of 75 MW(e) of solar power as a reasonable contribution to the combination of energy alternatives, based on the projections by DOE/EIA and MPSC.

Q49. Is the FEIS comparison of energy alternatives accurate and complete?

A49. [AJK, KAC] Yes. The Review Team formulated a set of energy alternatives, including one that consisted of a combination of energy alternatives. It followed the guidance in the ESRP, including ESRP 9.2.2 (NRC 2007 (Ex. NRC000008)), which states, "The energy conversion technology should be developed, proven, and available in the relevant region." The Review Team considered a range of values for certain contributors to the combination to illustrate the robustness of its assessment. The bases in selecting the value for each contribution to the combination of energy alternatives were described accurately and completely.

The Review Team recognizes that there are numerous other combinations that might be considered realistic as well. NEPA does not call for certainty, but it expects a hard look using a reasoned methodology and reasonable range of alternatives. Based on present technology and future projections, any reasonable energy alternative to the proposal (either individually or in combination with other energy technologies) to provide baseload capacity must involve a significant fossil-fueled component.

Therefore, as discussed above, the Review Team chose the reasonable contributions to the combination of energy alternatives identified in the FEIS. FEIS at 9-27 to 9-30 (Ex. NRC000003A).

Q50. Does this conclude your testimony?

A50. [AJK, KAC] Yes.

October 21, 2011

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
CALVERT CLIFFS 3 NUCLEAR PROJECT, LLC.	)	
AND UNISTAR NUCLEAR OPERATING	)	
SERVICES, LLC	)	Docket No. 52-016
	)	
(Combined License Application for Calvert Cliffs	)	
Unit 3)	)	

AFFIDAVIT OF ANDREW J. KUGLER CONCERNING PREFILED
TESTIMONY ON CONTENTION 10C

I, Andrew J. Kugler, do declare under penalty of perjury that my statements in the "Prefiled Direct Testimony of Andrew J. Kugler and Katherine A. Cort Concerning Environmental Contention 10C" and my statement of professional qualifications (Exhibit NRC000005) are true and correct to the best of my knowledge and belief.

Executed in Accord with 10 CFR § 2.304(d)
Andrew J. Kugler
Senior Environmental Project Manager
Division of Site and Environmental Reviews
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U.S. Nuclear Regulatory Commission
Mail Stop T7-E30
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(301) 415-2828
Andrew.Kulger@nrc.gov

Executed at Rockville, MD
this 21st day of October 2011

October 21, 2011

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
CALVERT CLIFFS 3 NUCLEAR PROJECT, LLC. AND UNISTAR NUCLEAR OPERATING SERVICES, LLC	)	Docket No. 52-016
	)	
(Combined License Application for Calvert Cliffs Unit 3)	)	

AFFIDAVIT OF KATHERINE A. CORT CONCERNING PREFILED TESTIMONY ON CONTENTION 10C

I, Katherine A. Cort, do declare under penalty of perjury that my statements in the "Prefiled Direct Testimony of Andrew J. Kugler and Katherine A. Cort Concerning Environmental Contention 10C" and my statement of professional qualifications (Exhibit NRC000006) are true and correct to the best of my knowledge and belief.

Executed in Accord with 10 CFR § 2.304(d)

Katherine A. Cort
Staff Scientist
Pacific Northwest National Laboratory
Battelle Memorial Institute
U.S. Department of Energy
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(509) 372-4374
Katherine.Cort@pnnl.gov

Executed at Rockville, MD
this 21th day of October 2011

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
CALVERT CLIFFS 3 NUCLEAR PROJECT, LLC. AND UNISTAR NUCLEAR OPERATING SERVICES, LLC	)	Docket No. 52-016
	)	
(Combined License Application for Calvert Cliffs Unit 3)	)	

PREFILED DIRECT TESTIMONY OF LAURA M. (QUINN) WILLINGHAM
SPONSORING NUREG-1936 INTO THE HEARING RECORD

Q1. Please state your name, occupation, and by whom are you employed.

A1. My name is Laura M. (Quinn) Willingham. I am employed as a Project Manager by the U.S. Nuclear Regulatory Commission's (NRC's) Office of New Reactors, Division of Site and Environmental Reviews[1]. A statement of my professional qualifications is included as Exhibit NRC000002.

Q2. Please describe your responsibilities in connection with the NRC Staff's review of the Calvert Cliffs Nuclear Power Plant Unit 3 (CCNPP) combined license (COL) application (Application).

A2. As the NRC Project Manager for the environmental review assigned to the Calvert Cliffs 3 Nuclear Project, LLC and UniStar Nuclear Operating Services, LLC (Applicant) Application for the COL at the Calvert Cliffs site in Calvert County, Maryland, I was responsible for overseeing the preparation of NUREG-1936, Volumes 1 and 2, "Environmental Impact Statement for the Combined License (COL) for Calvert Cliffs Nuclear Power Plant Unit 3: Final

[1] Effective December 1, 2011, Laura M. Willingham will be in the Office of New Reactors, Division of New Rector Licensing, Environmental Projects Branch 2.

Report" (FEIS) published in May 2011[2].

Q3. In that capacity, do you hereby sponsor the introduction of the FEIS into the record of this proceeding?

A3. I do.

Q4. Does this conclude your testimony?

A4. Yes.

[2] U.S. Nuclear Regulatory Commission, NUREG-1936, *Final Environmental Impact Statement for Combined Licenses (COLs) for Calvert Cliffs Nuclear Power Plant, Unit 3: Final Report, Volumes 1 and 2* (May 2011) (ML11129A167, ML11129A179) (Ex. NRC00003A, NRC00003B).

October 21, 2011

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
CALVERT CLIFFS 3 NUCLEAR PROJECT, LLC. AND UNISTAR NUCLEAR OPERATING SERVICES, LLC	)	Docket No. 52-016
	)	
(Combined License Application for Calvert Cliffs Unit 3)	)	

AFFIDAVIT OF LAURA M. (QUINN) WILLINGHAM CONCERNING PREFILED TESTIMONY SPONSORING NUREG-1936 INTO THE HEARING RECORD

I, Laura M. Willingham, do declare under penalty of perjury that my statements in the "Prefiled Direct Testimony of Laura M. (Quinn) Willingham Sponsoring NUREG-1936 into the Hearing Record" and my statement of professional qualifications (Exhibit NRC000002) are true and correct to the best of my knowledge and belief.

Executed in Accord with 10 CFR § 2.304(d)
Laura M. Willingham
Environmental Project Manager
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Executed at Rockville, MD
this 21th day of October 2011

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
CALVERT CLIFFS 3 NUCLEAR PROJECT,	)	
LLC, and UNISTAR NUCLEAR OPERATING	)	Docket No. 52-016-COL
SERVICES, LLC	)	
	)	
(Calvert Cliffs Nuclear Power Plant, Unit 3)	)	

NRC STAFF INITIAL STATEMENT OF POSITION

Anthony C. Wilson
Adam Gendelman

October 21, 2011

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UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

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LLC, and UNISTAR NUCLEAR OPERATING	)	Docket No. 52-016-COL
SERVICES, LLC	)	
	)	
(Calvert Cliffs Nuclear Power Plant, Unit 3)	)	

NRC STAFF INITIAL STATEMENT OF POSITION

Pursuant to 10 C.F.R. §§ 2.337(g)(2) and 2.1207(a)(1), and the Atomic Safety and Licensing Board's (Board) June 24, 2011 scheduling order,[1] the United States Nuclear Regulatory Commission staff ("Staff" or "NRC Staff") hereby submits its Initial Statement of Position and Direct Testimony, together with supporting Affidavits and Exhibits, regarding admitted Contention 10C.

As set forth in the Staff's Initial Statement of Position, Direct Testimony, and Exhibits, the FEIS has examined reasonable alternatives within the range dictated by the nature and scope of the proposal and has rigorously explored and objectively evaluated those reasonable alternatives. Accordingly, Contention 10C is without merit, as the Staff reasonably estimated solar and wind contributions in its combination of energy alternatives, and the Board should find in favor of the Staff.

[1] Order (Revising Initial Schedule) at 3 (June 24, 2011) (unpublished).

BACKGROUND

On July 13, 2007, UniStar Nuclear Development, LLC on behalf of Constellation Generation Group, LLC and UniStar Nuclear Operating Services submitted part of their application for a combined license (COLA) for one U.S. EPR pressurized water reactor to be located adjacent to the existing Calvert Cliffs Nuclear Power Plant (CCNPP), Units 1 and 2, near Lusby, Calvert County, Maryland. *UniStar Nuclear LLC*; Notice of Receipt and Availability of Part of an Application for a Combined License, 72 Fed. Reg. 45,832 (Aug. 15, 2007).[2]

On September 26, 2008, the NRC issued a notice of hearing and opportunity to intervene. Calvert Cliffs 3 Nuclear Project, LLC, and UniStar Nuclear Operating Services, LLC Notice of Hearing and Opportunity To Petition for Leave To Intervene and Order Imposing Procedures for Access to Sensitive Unclassified Non-Safeguards Information and Safeguards Information for Contention Preparation on a Combined License for the Calvert Cliffs Nuclear Power Plant 3, 73 Fed. Reg. 55,876 (Sept. 26, 2008). On November 19, 2008, multiple entities jointly filed a petition to intervene in the proceeding proffering seven contentions. *See* Petition to Intervene in Docket No. 52-016, Calvert Cliffs-3 Nuclear Power Plant Combined Construction and License Application at 5 (Nov. 19, 2008) (Petition).

On March 24, 2009, the Atomic Safety and Licensing Board admitted the petitioners as parties to this proceeding, collectively referred to as "Joint Intervenors," and admitted three contentions. *Calvert Cliffs 3 Nuclear Project, LLC, and UniStar Nuclear Operating Services, LLC* (Combined License Application for Calvert Cliffs Unit 3), LBP-09-04, 69 NRC 170, 190-196, *aff'd in relevant part*, CLI-09-20, 70 NRC 911, 918-21 (2009).

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[2] The original COL applicants were Constellation Generation Group, LLC and UniStar Nuclear Operating Services, LLC. The application was revised by letter dated August 1, 2008, which among other things changed the applicants to Calvert Cliffs 3 Nuclear Project, LLC and UniStar Nuclear Operating Services, LLC (collectively, Applicants).

On April 13, 2010, NRC Staff issued NUREG-1936, *Environmental Impact Statement for the Combined License (COL) for Calvert Cliffs Nuclear Power Plant Unit 3, Draft Report for Comment* (April 2010) (DEIS).[3] On June 25, 2010, the Joint Intervenors submitted Contention 10, challenging the adequacy of the DEIS with respect to the need for power, energy alternatives, and the relative costs and benefits of the proposed new nuclear unit. Submission of Contention 10 by Joint Intervenors at 1 (June 25, 2010) (Intervenors' Original Contention 10). NRC Staff and the Applicants opposed the admission of this contention. NRC Staff Answer to Joint Intervenors' New Contention 10 (July 20, 2010); Applicants' Response to Proposed Contention 10 (July 20, 2010).

In an order issued on December 28, 2010, the Board reformulated and admitted one part of proposed Contention 10, concerning combination of alternatives, as Contention 10C, and rejected each of the Intervenors' other challenges to the DEIS for failure to meet the contention admissibility requirements in 10 CFR § 2.309(f)(1) and (f)(2). *Calvert Cliffs 3 Nuclear Project, LLC, and UniStar Nuclear Operating Services, LLC* (Combined License Application for Calvert Cliffs Unit 3), LBP-10-24, 72 NRC __, __ (Dec. 28, 2010) (slip op. at 1, 20, 38, 44, 54, 62). Contention 10C challenged the DEIS's wind and solar power contribution estimates as inadequate. As admitted, Contention 10C reads as follows:

> The DEIS discussion of a combination of alternatives is inadequate and faulty. By selecting a single alternative that under represents potential contributions of wind and solar power, the combination alternative depends excessively on the natural gas supplement, thus unnecessarily burdening this alternative with excessive environmental impacts.

Id.

On May 20, 2011, Staff issued the Final Environmental Impact Statement (FEIS) for the proposed project. *See* 76 Fed. Reg. 29,279 (May 20, 2011); NUREG-1936, *Environmental*

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[3] The DEIS is contained in two volumes. Volume 1 (ML101000012) includes Chapters 1 - 10. Volume 2 (ML101000013) includes Appendices A through M.

Impact Statement for the Combined License for Calvert Cliffs*, Nuclear Power Plant Unit 3, Final Report* (May 2011) (ADAMS Accession Nos. ML11129A167 and ML11129A179).

On June 20, 2011, Applicants moved for summary disposition of Contention 10C on the grounds that the FEIS addressed the issues raised by the Intervenors in Contention 10C; the Applicants argued that no genuine issue remains as to any material fact relevant to the contention. *See* Applicant's Motion for Summary Disposition of Contention 10C (June 20, 2011) (Applicants' Motion). On July 11, 2011, NRC Staff filed an answer to Applicant's Motion in which it did not oppose Applicant's Motion for Summary Disposition of Contention 10C. *See* NRC Staff's Response to Applicants' Motion for Summary Disposition (July 11, 2011). Joint Intervenors did not file a response to the Applicants Motion.[4]

Also on June 20, 2011, the Joint Intervenors filed a "Submission of Amended Contention 10C" in which they, among other things, sought to update the original bases of Contention 10C to reflect additional arguments concerning the FEIS. *See* Submission of Amended Contention 10C by Joint Intervenors (June 20, 2011) (Joint Intervenors' Submission). On July 15, 2011, NRC Staff filed its response to the Joint Intervenors' Submission. *See* NRC Staff Answer to Joint Intervenors' Amended Contention 10C (July 15, 2011). In its response, NRC Staff did not oppose the proposed change of reference from DEIS to FEIS in contention 10C, but opposed the Joint Intervenors' Submission in all other respects for failure to meet the contention admissibility requirements in 10 C.F.R. § 2.309(f)(1) and (f)(2).

On August 26, 2011, the Licensing Board issued a decision that denied the Applicants' Motion for Summary Disposition, and denied admission of the Joint Intervenors' amended

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[4] The Board, in its Memorandum and Order of August 26, 2011, considered the Joint Applicants' arguments made in its June 20, 2011 "Submission of Amended Contention 10C" in ruling on the Applicant's Motion. *Memorandum and Order (Denying Summary Judgment of Contention 10C, Denying Amended Contention 10C, and Deferring Ruling on Contention 1)* at 5, n.21 (Aug. 26, 2011) (unpublished) (Aug. 26, 2011 Order).

contention.[5] The Licensing Board directed the parties to proceed to evidentiary hearing according to the Board's Revised Initial Scheduling Order on Contention 10C.

DISCUSSION

I. Legal Standards

The contention at issue in this proceeding arises under the National Environmental Policy Act (NEPA), and the NRC's regulations that implement that statute. *See* 42 U.S.C. § 4321 (2006); 10 C.F.R. Part 51. NEPA requires that an agency prepare an Environmental Impact Statement (EIS) for major Federal action that significantly affect the quality of the human environment. 42 U.S.C. § 4332(2)(C). The NRC has determined that the Issuance of a COL is an action that requires an EIS. 10 C.F.R. § 51.20.

Under NEPA, the NRC is required to take a "hard look" at the environmental impacts of a proposed action, as well as reasonable alternatives to that action. *See Louisiana Energy Servs., L.P.* (Claiborne Enrichment Center), CLI-98-3, 47 NRC 77, 87-88 (1998). This "hard look" is tempered by a "rule of reason" that requires agencies to address only impacts that are reasonably foreseeable – not remote and speculative. *See, e.g., Long Island Lighting Co.* (Shoreham Nuclear Power Station, Unit 1), ALAB-156, 6 AEC 831, 836 (1973). "NEPA does not call for certainty or precision, but an *estimate* of anticipated (not unduly speculative) impacts." *Louisiana Energy Servs.* (National Enrichment Facility), CLI-05-20, 62 NRC 523, 536 (2005) (emphasis in original). Further, "NEPA gives agencies broad discretion to keep their inquiries within appropriate and manageable boundaries." *Louisiana Energy Servs., L.P.*, CLI-98-3, 47 NRC at 103 (internal citation omitted).

With respect to alternatives analysis, NEPA does not require a detailed discussion of alternatives deemed remote and speculative or whose effects cannot be readily ascertained.

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[5] Aug. 26, 2011 Order at 32.

Vermont Yankee Nuclear Power Corp. v. NRDC, 435 U.S. 519, 551 (1978) (quoting *NRDC v. Morton*, 458 F.2d 827, 837–38 (1972)).

> Common sense also teaches us that the 'detailed statement of alternatives' cannot be found wanting simply because the agency failed to include every alternative device and thought conceivable by the mind of man.

Id. at 551 As noted in the *Vermont Yankee* case, "the concept of 'alternatives' is an evolving one, requiring the agency to explore more or fewer alternatives as they become better known and understood." *Id*. at 552-53. Whether an alternative is remote and speculative must be decided by the agency "in light of the facts then available to it" and an agency action cannot be found to be arbitrary and capricious based upon later facts. *Id*. at 554 (quoting *ICC v. Jersey City*, 322 U.S. 503, 514 (1944)). "An agency's consideration of alternatives is sufficient if it considers an appropriate range of alternatives, even if it does not consider every available alternative." *Headwaters, Inc. v. Bureau of Land Management, Medford Dist*., 914 F.2d 1174, 1181 (9th Cir. 1990).

In considering alternatives under NEPA, an agency must "take into account the needs and goals of the parties involved in the application." *Private Fuel Storage, LLC* (Independent Spent Fuel Storage Installation), CLI-04-22, 60 NRC 125, 146 (2004) (*Private Fuel Storage, LLC*). When considering alternatives, the Commission has held that it is appropriate to consider the stated purposes of the project and the needs of the Applicant. *See USEC Inc.* (American Centrifuge Plant), CLI-06-10, 63 NRC 451, 467 (2006) (*USEC Inc.*) (in which the Commission stated that intervenor "erroneously appears to assume that the NEPA analysis of 'alternatives' should ignore the stated purposes of the project *and the Applicant's needs.*") (emphasis added). Finally, decisions on alternatives may deal with circumstances "as they exist and are likely to exist." *Carolina Environmental Study Group v. United States*, 510 F.2d 796, 801 (D.C. Cir. 1975) (*Carolina Environmental Study Group)*.

In challenging the Staff's environmental review, intervenors must identify, with some specificity, the alleged deficiencies in the Staff's NEPA analysis. *See Hydro Resources, Inc.*

(Albuquerque, NM), CLI-99-22, 50 NRC 3, 13 (1999). While there may be mistakes in the EIS, mistakes that are not significant or material do not indicate that the Staff's NEPA review was inadequate. *See Exelon Generation Co.* (Early Site Permit (ESP) for Clinton Site), CLI-05-29, 62 NRC 801, 811 (2005) ("[I]n an NRC adjudication, it is Intervenors' burden to show the "significance and materiality" of mistakes in the EIS). The Staff's NEPA analysis is adequate unless the Staff "has failed to take a 'hard look' at significant environmental questions – i.e., the Staff has unduly ignored or minimized pertinent environmental effects." *See Duke Energy Corp.* (McGuire Nuclear Station, Units 1 & 2; Catawba Nuclear Station, Units 1 & 2), CLI-03-17, 58 NRC 419, 431 (2003) (discussing what an intervenor must allege, with adequate support, to litigate a NEPA claim) ("*Duke Energy Corp.")*. As the Commission has stated, "[o]ur Boards do not sit to 'flyspeck' environmental documents or to add details or nuances. If the ER (or EIS) on its face comes to grips with all important considerations nothing more need be done." *Clinton ESP,* CLI-05-29, 62 NRC at 811 (quoting *System Energy Resources, Inc.* (Early Site Permit for Grand Gulf Site), CLI-05-4, 61 NRC 10, 13 (2005)).

Finally, "in an adjudicatory hearing, to the extent that any environmental findings by the Presiding Officer (or the Commission) differ from those in the FEIS, the FEIS is deemed modified by the decision." *Hydro Resources, Inc.* (Rio Rancho, NM), CLI-01-4, 53 NRC 31, 53 (2001). The hearing process serves the public participation purposes of NEPA because it allows for "more rigorous public scrutiny" of an EIS than "circulation for comment." *See id.* at 53 (quoting *Philadelphia Electric Co.* (Limerick Generating Station, Units 1 and 2), ALAB-819, 22 NRC 681, 707 (1985)).

II. <u>NRC Staff Witnesses for Contention 10C</u>

The "Prefiled Direct Testimony of Laura M. (Quinn) Willingham Sponsoring NUREG-1936 into the Hearing Record" (Exhibit NRC000001) sponsors the introduction of the Staff's

FEIS into the record of this proceeding as required by 10 C.F.R. § 2.337(g).[6] The remaining testimony presents the opinions of staff witnesses for Contention 10C. For Contention 10C, the panel of witnesses consists of Andrew J. Kugler and Katherine A. Cort. They have authored the "Prefiled Direct Testimony of Andrew J. Kugler and Katherine A. Cort Regarding Contention 10C" (Ex. NRC000004) (NRC Staff Testimony).[7]

Andrew J. Kugler and Katherine A. Cort have provided testimony regarding the Staff's position with respect to Contention 10C. NRC Staff Testimony at A1.[8] NRC Staff Testimony presents the opinions of two qualified witnesses and demonstrates, as set forth below, that the FEIS prepared by the Staff to meet its obligations under NEPA includes an adequate discussion of a combination of energy alternatives. *Id*. NRC Staff rigorously explored and objectively evaluated reasonable alternatives within the range dictated by the nature and scope of the applicant's proposal and the NRC Staff-developed purpose and need statement. The Staff concluded that there are no environmentally preferable alternatives to the proposed action with respect to energy alternatives. NRC Staff Testimony at A35; *see also* FEIS at 9-28 (NRC000003A).

III. <u>The Energy Alternatives Discussion in the FEIS is Adequate</u>

A. <u>The Board Should Find for Staff on Contention 10C</u>

1. NRC Staff Examined Technically Feasible and Commercially Viable Energy <u>Alternatives in the Region of Interest</u>

In preparing the FEIS, NRC Staff assessed the environmental impacts of technically feasible and commercially exploitable energy alternatives that would be available in Maryland,

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[6] Volume 1 (ML11049A000) can be found in Ex. NRC000003A, Volume 2 (ML11129A179) can be found at Ex. NRC000003B.

[7] NRC Staff's testimony is also supported by numerous exhibits, The list of NRC Staff exhibits is contained in NRC Staff Attachment 1.

[8] In the Staff's testimony, each question and answer is consecutively numbered, and citations to testimony in this pleading are to answer numbers.

the region of interest, able to meet the purpose and need of the project within the timeframe of the proposed project, and would to contribute to the projected demand for electrical energy. NRC Staff Testimony at A10. Consistent with the environmental standard review plan, the NRC Staff determined that given that the proposed project is intended to supply baseload power, a competitive alternative would also need to be capable of supplying baseload power. NRC 2007 ESRP 9.2.2 at 3 (Ex. NRC0000008); *see also Private Fuel Storage, LLC* at 146 (finding that "it is appropriate to consider the stated purposes of the project"); *USEC Inc.* at 467 (rejecting intervenor assertion that the NEPA analysis of 'alternatives' should ignore the stated purposes of the project).

In developing reasonable alternative energy sources, NRC Staff relied upon the insights of the U.S. Department of Energy (DOE), as the agency responsible for energy planning in the U.S, as a reliable source for future predictions and market analyses. NRC Staff did not assume that each individual energy technology would be able to reach its theoretical maximum potential. Rather, NRC Staff struck a balance between the limited implementation successes for energy technologies such as wind and solar and the potential of the resource. The resulting combination of energy alternatives represents what NRC Staff concluded could be reasonably be achieved within the region of interest and the timeframe of the proposed project. NRC Staff Testimony at A18.

2. NRC Staff Evaluated Combinations of Energy Alternatives

NRC Staff considered a combination of energy alternatives that included the maximum contribution from renewable sources that would be reasonably foreseeable, within the region of interest, and within the timeframe of the proposed project. In doing so, NRC Staff minimized to the extent feasible the size of the contribution from natural gas generation. NRC Staff Testimony at A48. To determine the contribution of wind power to the combination energy alternatives, NRC Staff primarily relied on U.S. DOE's Annual Energy Outlook National

Renewable Energy Laboratory (NREL) 2010 report related to large-scale off-shore wind in the United States, and the Maryland Public Service Commission's (MPSC) Ten-Year Plan. (Ex. NRC000016). NRC Staff Testimony at A34. For the ReliabilityFirst Corporation/East region which includes Maryland,[9] DOE/EIA projects a growth of 420 MW(e) of on-shore wind capacity and 200 MW(e) of offshore wind capacity between 2010 and 2035. DOE/EIA 2011b (Ex. NRC000022). NRC Staff conservatively assumed that Maryland accounts for a third of this growth, which would equate to about 210 MW(e). NRC Staff Testimony at A34. Using 34 percent for the capacity factor of wind, this 210 MW(e) of wind capacity equates to about 71 MW(e) of baseload capacity. The NRC Staff value of 100 MW(e) in the combination of energy alternatives is reasonable in comparison to the DOE/EIA projection. While the data from EIA are projections, based on the limited wind development in Maryland, it would be unreasonable to expect large-scale development of this resource within the timeframe of the proposed project, and thus it is appropriate to not include a larger wind contribution to the combination of energy alternatives discussion, and not include a further discussion of wind in the FEIS. *Id*. NEPA does not require a detailed discussion of the environmental effects of alternatives put forward in comments when these effects cannot be readily ascertained and the alternatives are deemed only remote and speculative possibilities. *Vermont Yankee Nuclear Power Corp. v. NRDC*, 435 U.S. 519, 551 (1978) (quoting *NRDC v. Morton*, 458 F.2d 827, 837–38 (1972)). Decisions on alternatives may deal with them "as they exist and are likely to exist." *Carolina Environmental Study Group v. United States*, 510 F.2d 796, 801 (D.C. Cir. 1975). Accordingly, NRC Staff has satisfied its burden with respect to wind resources in the combination of energy alternatives.

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[9] The ReliabilityFirst Corporation/East region is formerly the Mid-Atlantic Area Council. ReliabilityFirst Corporation is one of eight regional electric reliability councils that sets and enforces electric reliability standards. Maryland is in the ReliabilityFirst Corporation territory. RFC 2011 (Ex. NRC000020).

NRC Staff developed contributions to the combination of alternatives from energy sources that it determined to be possible contributors; wind, solar, hydropower, biomass (including municipal solid waste), and conservation and demand-side management programs. For the combination of energy alternatives, the NRC Staff considered which of these sources to include and what amount they could contribute. While any number of options and variations is theoretically possible, NRC Staff selected those alternative energy sources that are available in Maryland, and at levels of contribution that the Staff reasonably expects could be achieved to meet the purpose and need of the project within the timeframe of the proposed project. NRC Staff Testimony at A17. In keeping with NEPA principles, NRC Staff established a reasonable combination of energy alternatives to meet the purpose and need for the proposed project and that is not inconsistent with energy plans and planning documents for Maryland. *Id., see also* MPSC 2009b (Ex. NRC000016); MPSC 2007 (Ex. NRC000017).

With respect to wind and solar power, NRC Staff, as set forth below, concluded that if wind and solar power were utilized as energy alternatives, the alternatives would need to be coupled with a storage mechanism such as compressed air storage system (“CAES”) to provide baseload power. NRC Staff Testimony at A44. Specifically, Staff determined that the largest feasible contribution from wind power would be 100 MW(e). NRC Staff Testimony at A34. For wind power, 100 MW(e) equates to at least 250 to 300 MW(e) of installed capacity[10] coupled with a 100 MW(e) CAES plant. The contribution from solar power was assumed to be smaller based on the marginal solar power potential for large-scale projects in the Maryland region. NRC Staff Testimony at A48; FEIS at 9-28 (NRC00003A). The alternate energy sources, including wind and solar, added up to a baseload equivalent of 400 MW(e). NRC Staff allocated the remaining 1200 MW(e) of baseload needed to non-renewable energy sources - coal or

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[10] Note that this amount of capacity is based simply on the capacity factor of wind. It ignores the fact that there will be extended periods of low wind that will exhaust the stored energy capacity of the CAES facility, requiring some other source of electrical power to back up the wind/CAES combination.

natural gas. Of the two, NRC Staff determined that natural gas resulted in the least environmental impacts. NRC Staff Testimony at A25.

NRC Staff considered a scenario in which the wind contribution was quadrupled to 400 MW(e) of baseload power, equivalent to an installed capacity of at least 1000 to 1200 MW(e) with a 400-MW(e) CAES plant. NRC Staff concluded that, under this scenario, the combination alternative would require 900 MW(e) from natural gas-fired plant in order to meet the target generation capacity of 1600 MW(e). NRC Staff Testimony at A35; FEIS at 9-28 to 9-30 (Ex. NRC000003A). Staff determined that the CAES plant in this scenario would be larger than any such facility worldwide and offshore wind capacity of this magnitude exceeds by a factor of five or more the amount of offshore wind projected by DOE/EIA for the entire United States by the year 2030[11] (Ex. NRC000022). Under this scenario, the impact categorizations in Table 9-3 in the FEIS (Ex. NRC00003A) would not change, except that impacts to land use and terrestrial ecology might become LARGE if onshore wind energy is used. If offshore wind is the energy source, then increased impacts to aquatic ecology, aesthetics and recreation (as a minimum) would occur from the building and operation of the turbines. NRC Staff Testimony at A35; FEIS at 9-28 to 9-30 (Ex. NRC00003A).

There is utility-scale wind energy in Maryland; but there are only two moderate-sized projects (50 MW(e) and 70 MW(e), and they are both onshore projects. Gestamp 2011 (Ex. NRC000025); Constellation 2010 (Ex. NRC000026). No Maryland wind projects are approved for offshore locations. The first of the two operating wind projects in Maryland, the 70 MW(e) Criterion onshore wind project, went online in December 2010. The other, the 50 MW(e) onshore Roth Rock project, went online in July 2011 (Ex. NRC000025). The NRG Bluewater Wind project off the nearby Delaware coast in Federal waters is currently planned to have a

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[11] NRC Staff found that the DOE/EIA projection for offshore wind power has not changed in the Annual Energy Outlook 2011. DOE/EIA 2011 (Ex. NRC000012).

capacity of 450 MW(e). NRC Staff Testimony at A32. Joint Intervenors expressed a concern that NRC Staff had not included the Bluewater Wind project off the coast of Maryland in the FEIS. Joint Intervenors 2011 at 4. The NREL report (2010) does not include the Bluewater Wind project in Maryland in the list of projects that have advanced permitting because that project has not made any significant progress in the leasing/permitting process, which has lasted over 10 years in the case of the Cape Wind offshore wind project off the coast of Cape Cod, Massachusetts. *See* US ACE 2011 (Ex.NRC000030). Thus, the Staff did not consider the Bluewater Wind project in Maryland to be reasonably foreseeable and did not include it in its combination alternative analysis. *See Private Fuel Storage, LLC* at 146; *USEC Inc.* at 467; NRC Testimony at A33.

NRC Staff concluded that it is unlikely that a project such as the Bluewater Wind project in Maryland, that has not made any significant progress in the leasing/permitting process, could be operational within the timeframe of the proposed project. NRC Staff Testimony at A32.

> The Review Team reviewed the Wind Technologies Market Report (DOE/EERE 2011 (Ex. NRC00029)), which found, consistent with the 2010 NREL report, that: "To date, no offshore projects have been installed in the United States, and the emergence of a U.S. offshore wind power market still faces many challenges. Perhaps most importantly, the projected near-term costs of offshore wind energy remain high. Additionally, though political support exists for offshore wind energy in some quarters, planning, siting, and permitting can be challenging, as demonstrated in the long history of the Cape Wind project. Competing uses of offshore waters and public concerns can complicate the process and, despite recent progress in clarifying the permitting procedures in federal waters, uncertainties in federal and state permitting processes remain."

Id.

NRC Staff notes that the MPSC considered the development potential for wind power in Maryland in a 2008 report (MPSC 2008b (Ex. NRC000023)) and concluded the economic benefits from renewable sources remain uncertain and challenging. MPSC found that onshore wind yields net economic benefits, albeit on a small scale. Additionally, MPSC found that, offshore wind, as modeled in the report, does not yield economic benefits. FEIS at 9-20 (Ex. NRC00003A). NRC Staff concluded that offshore wind would not significantly contribute to the combination of energy alternatives in the timeframe of the proposed project. NRC Staff Testimony at A33.

In evaluating the potential contribution of solar power in the combination of energy alternatives, NRC Staff first considered the likelihood that there would be additions of solar generating capacity in Maryland. DOE/EIA predicts 0 MW(e) for utility solar capacity between 2010 and 2035 in the Region that includes Maryland, and the addition of 810 MW(e) of end-use solar capacity (all photo-voltaic, or PV) in that region over the same period. DOE/EIA 2011b (Ex. NRC000022); NRC Staff Testimony at A42. End-use facilities are typically of small size because they are only designed to meet a specific local need. Assuming that Maryland accounts for roughly a third of the region, additions of end-use solar capacity in Maryland by 2035 would be about 270 MW(e). According to DOE/EIA, an average solar capacity factor ranges from 18 to 25% in the U.S. DOE/EIA 2010b (Ex. NRC000010). Using 25% for simplicity, the 270 MW(e) of capacity equates to about 68 MW(e) of baseload capacity. Typical solar-to-electric power plants require 5 to 10 acres for every MW(e) of generating capacity. NRC Staff Testimony at A42; FEIS at 9-23 (Ex. NRC00003A). Using this number, the 270 MW(e) (75 MW(e) baseload equivalent) solar contribution would impact 1350 to 2700 acres of land and associated terrestrial resources. A larger solar contribution would impact a correspondingly larger land area. The NRC Staff concluded that a value of 75 MW(e) in the combination of energy alternatives is reasonable in comparison to the DOE/EIA projection. *Id*.

Staff concluded, based upon its extensive review of the viability of the energy production technologies within the region of interest, a 100 MW(e) wind and 75 MW(e) solar baseload equivalent contribution to the combination of energy alternatives were reasonable. NRC Staff Testimony at A42. The range of alternatives considered by the NRC Staff in making the aforementioned determination in the FEIS need not, and did not, extend beyond those alternatives reasonably related to the purposes of the project. *See Private Fuel Storage, LLC*; *see USEC Inc*.

3. NRC Staff Evaluated Storage Resources

NRC Staff evaluated alternative energy resource combinations together with storage that included the maximum contribution from renewable sources that would be reasonably foreseeable within the region of interest and within the timeframe of the proposed project. Specifically, NRC Staff considered wind or solar power "in conjunction with energy storage mechanisms such as pumped hydroelectric or CAES, or another readily dispatchable power source, such as hydropower, might serve as a means of providing baseload power." As stated in Section 9.2.3.2 of the FEIS (Ex. NRC00003A), a pumped storage or other hydroelectric facility is highly unlikely based on the DOE/EIA projection for pumped storage (Ex. NRC000022) and the low potential for new hydroelectric development in Maryland. Conner and Francfort 1997 (Ex. NRC000042).

NRC Staff evaluated CAES facilities. FEIS Section 9.2.3.2 (Ex. NRC00003A). To date one facility was built in 1978 (290 MW(e), in Germany) and another in 1991 (110 MW(e), in Alabama). Additionally, NRC Staff considered a current proposal for a 268 MW(e) CAES plant coupled to a wind farm in Iowa, and other proposals in various stages of development in the U.S. *Id*. None of the proposals are for a facility in Maryland, and it is unclear that such a facility could be sited in the State of Maryland. *Id*. NRC Staff found no evidence that any company has made any proposal for a CAES facility in Maryland. NRC Staff Testimony at A46. ESRP 9.2.2 (NRC 2007 (Ex. NRC000008)) states that the "energy conversion technology should be developed, proven, and available in the relevant region." Staff concluded that including a large CAES facility in Maryland would be speculative and not within the reasonable range of alternatives to be considered in the staff's NEPA analysis, based on the history and current state of CAES development. *Id.* NRC Staff concluded that a large CAES facility, beyond the 175 MW(e) assumed in the combination of energy alternatives, was not a reasonable alternative. *Id*. NRC Staff's NEPA analysis and the resulting FEIS adequately addressed the alternatives, and combination of alternatives, and circumstances thereof as they exist and are likely to exist. *See Carolina Environmental Study Group*, 510 F.2d at 801.

CONCLUSION

As set forth in the NRC Staff Direct Testimony, Affidavits, and Exhibits, and as summarized herein, the NRC Staff in preparing the FEIS examined reasonable alternatives within the range dictated by the nature and scope of the Applicant's proposal and the NRC Staff's developed purpose and need statement. As noted "the concept of 'alternatives' is an evolving one, requiring the agency to explore more or fewer alternatives as they become better known and understood." *Vermont Yankee*, 435 U.S. at 552-53. As set forth herein, NRC Staff, in developing the FEIS, evaluated an array of energy alternatives including traditional sources (such as natural gas) and evolving sources (such as wind, solar, and biofuels). Additionally, NRC Staff evaluated a combination of energy alternatives that included reasonable contributions from wind and solar coupled with CAES. Finally, NRC Staff analyzed alternatives "as they exist and are likely to exist" consistent with the holding in *Carolina Environmental Study Group.* Moreover, consistent with the requirements of NEPA, in conducting its analysis the NRC Staff has taken a hard look at significant environmental questions, and did not unduly ignore or minimize pertinent environmental effects. *See Duke Energy Corp.*

NRC Staff concluded that none of the proposed energy alternatives or combination of alternatives identified by Staff would be environmentally preferable to the proposed action. Specifically, none of the energy alternatives identified: (1) were capable of meeting the purpose and need of the project; (2) were in the region of interest; (3) could meet the timeframe of the proposed project; and (4) were environmentally preferable to the proposed project.

Accordingly, Joint Intervenors' Contention 10C is without merit and the Board should find in favor of the NRC Staff.

Respectfully submitted,

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/Executed in accord with 10 C.F.R. § 2.304(d)/

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Dated at Rockville, Maryland
this 21st day of October, 2011

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of	)	
	)	
CALVERT CLIFFS 3 NUCLEAR PROJECT, LLC, and UNISTAR NUCLEAR OPERATING SERVICES, LLC	)	Docket No. 52-016-COL
	)	
(Calvert Cliffs Nuclear Power Plant, Unit 3)	)	

CERTIFICATE OF SERVICE

I hereby certify that copies of NRC Staff Initial Statement of Position, NRC Staff Attachment 1 (Exhibit List), and Exhibits NRC000001 through NRC000042, including direct prefiled testimony and supporting affidavits (exhibits NRC000001 and NRC000004) have been served upon the following persons by Electronic Information Exchange this 21st day of October, 2011:

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Calvert Cliffs 3 Nuclear Project, L.L.C., and UniStar Nuclear Operating Services, L.L.C.
(Combined License Application for Calvert Cliffs Unit 3)
Docket No. 52-016-COL
ASLBP No. 09-874-02-COL-BD01
January 26, 2012 Evidentiary Hearing

NRC Staff Hearing Exhibits

NRC Staff Exhibit #	Witness/Panel	Description
NRC000001	L. M. (Quinn) Willingham	"Prefiled Direct Testimony of Laura M. (Quinn) Willingham Sponsoring NUREG-1936 Into the Hearing Record" and "Affidavit of Laura M. (Quinn) Willingham Concerning Prefiled Testimony Sponsoring NUREG-1936 Into The Hearing Record."
NRC000002	L. M. (Quinn) Willingham	Statement of Professional Qualifications for L. M. (Quinn) Willingham.
NRC00003A	L. M. (Quinn) Willingham A. Kugler; K. Cort	U.S. Nuclear Regulatory Commission, NUREG-1936, *Final Environmental Impact Statement for Combined Licenses (COLs) for Calvert Cliffs Nuclear Power Plant, Unit 3: Final Report*, Volume 1 (May 2011) (ML11129A167).
NRC00003B	L. M. (Quinn) Willingham A. Kugler	U.S. Nuclear Regulatory Commission, NUREG-1936, *Final Environmental Impact Statement for Combined Licenses (COLs) for Calvert Cliffs Nuclear Power Plant, Unit 3: Final Report*, Volume 2 (May 2011) (ML11129A179).
NRC000004	A. Kugler; K. Cort	"Prefiled Direct Testimony of Andrew J. Kugler, and Katherine A. Cort Regarding Contention 10C" and "Affidavit of Andrew J. Kugler Concerning Prefiled Testimony Regarding Contention 10C" and "Affidavit of Katherine A. Cort Concerning Prefiled Testimony Regarding Contention 10C."
NRC000005	A. Kugler	Statement of Professional Qualifications for Andrew J. Kugler
NRC000006	K. Cort	Statement of Professional Qualifications for Katherine A. Cort.

NRC Staff Exhibit #	Witness/Panel	Description
NRC000007	A. Kugler	73 Fed. Reg. 55,546 (Sept. 25, 2008). "Notice of Availability of Memorandum of Understanding Between U.S. Army Corps of Engineers and U.S. Nuclear Regulatory Commission on Environmental Reviews Related to the Issuance of Authorization to Construct and Operate Nuclear Power Plants." Federal Register. U.S. Nuclear Regulatory Commission. (73 FRN 55546)
NRC000008	A. Kugler; K. Cort	U.S. Nuclear Regulatory Commission, NUREG-1555, *Environmental Standard Review Plan -- Standard Review Plans for Environmental Reviews for Nuclear Power Plants*, Rev. 1, Sections 8.4, 9.2.1, 9.2.2, 9.2.3 (2007) (ML071810034, ML071830296, ML071830302, ML071830304) (NRC 2007).
NRC000009	A. Kugler	U.S. Nuclear Regulatory Commission, Staff Memorandum from Andrew Kugler, Senior Project Manager, to Brent Clayton, RENV Branch Chief, *Supplemental Staff Guidance to NUREG 1555, "Environmental Standard Review Plan," (ESRP) for Alternatives Reviews* (Apr. 26, 2010) (ML100840031) (NRC 2010a).
NRC000010	A. Kugler; K. Cort	U.S. Nuclear Regulatory Commission, Staff Memorandum from Jack Cushing, Senior Project Manager, to Brent Clayton, RENV Branch Chief, *Supplemental Staff Guidance for Cumulative Effects Analysis* (Apr. 8, 2010) (ML100990271) (NRC 2010b).
NRC000011	A. Kugler; K. Cort	UniStar Nuclear Energy, Calvert Cliffs Nuclear Power Plant Unit 3 Combined License Application, Part 1: General Information, Revision 7, Section 1.1.3 (Dec. 20, 2010) (ML103620352) (UniStar 2010).
NRC000012	A. Kugler; K. Cort	Electricity Terms and Definitions, U.S. Department of Energy, Energy Information Administration, http://www.eia.gov/cneaf/electricity/page/glossary.html (last visited on Sept. 19, 2011) (DOE/EIA 2011a).
NRC000013	A. Kugler; K. Cort	John Hynes, *How to Compare Power Generation Choices*, Renewable Energy World.com (Oct. 29, 2009), http://www.renewableenergyworld.com/rea/news/article/2009/10/how-to-compare-power-generation-choices (Hynes 2009).
NRC000014	A. Kugler; K. Cort	Maryland Public Service Commission, In the Matter of the Application of UniStar Nuclear Energy, LLC and UniStar Nuclear Operating Services, LLC for a Certificate of Public Convenience and Necessity to Construct a Nuclear Power Plant at Calvert Cliffs in Calvert County, Maryland, Case Number 9127, Order Number 82741 (June 26, 2009) (MPSC 2009a).
NRC000015	A. Kugler; K. Cort	Maryland Public Service Commission, In the Matter of the Application of UniStar Nuclear Energy, LLC and UniStar Nuclear Operating Services, LLC for a Certificate of Public Convenience and Necessity to Construct a Nuclear Power Plant at Calvert Cliffs in Calvert County, Maryland, Case Number 9127, Proposed Order of Hearing Examiner (Apr. 28, 2009) (MPSC 2009c).

NRC Staff Exhibit #	Witness/Panel	Description
NRC000016	A. Kugler; K. Cort	Maryland Public Service Commission, Ten-Year Plan (2008-2017) of Electric Companies in Maryland (2009), *available at* http://webapp.psc.state.md.us/Intranet/psc/Reports_new.cfm (MPSC 2009b).
NRC000017	A. Kugler; K. Cort	Maryland Public Service Commission, Electric Supply Adequacy Report of 2007 (2007), *available at* http://webapp.psc.state.md.us/Intranet/Reports/2007SupplyAdequacyReport_01172007.pdf (MPSC 2007).
NRC000018	A. Kugler; K. Cort	Maryland Public Service Commission, Ten-Year Plan (2009 – 2018) of Electric Companies in Maryland (2010), *available at* http://webapp.psc.state.md.us/Intranet/psc/Reports_new.cfm (MPSC 2010).
NRC000019	A. Kugler; K. Cort	ReliabilityFirst Corporation, Long Term Resource Assessment 2009-2018 (2009) (ML100481002) (RFC 2009).
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NRC000026	A. Kugler; K. Cort	*Power Generation: Generation Facilities*, Constellation Energy, http://www.constellation.com/portal/site/constellation/menuitem.24df26f4581930908d84ff10025166a0 (last visited Jan. 7, 2011) (Constellation 2011).
NRC000027	A. Kugler; K. Cort	U.S. Department of Interior, Interior Initiates Process for First "Smart for the Start" Lease for Commercial Wind Power Offshore Delaware: Determines No Competitive Interest for Area Proposed by NRG Bluewater Wind Delaware, LLC (2011), *available at* http://www.doi.gov/news/pressreleases/Interior-Initiates-Process-for-First-Smart-from-the-Start-Lease-for-Commercial-Wind-Power-Offshore-Delaware.cfm (ML110950238) (DOI 2011).
NRC000028	A. Kugler; K. Cort	Maryland Public Service Commission, Ten-Year Plan (2010 – 2019) of Electric Companies in Maryland (2011), *available at* http://webapp.psc.state.md.us/Intranet/psc/Reports_new.cfm (MPSC 2011).
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NRC000034	A. Kugler; K. Cort	Southern Co. and Georgia Institute of Technology, Southern Winds: Summary Project Report 2007: A Study of Wind Power Generation Potential off the Georgia Coast (2007), *available at* http://www.energy.gatech.edu/research/Summary-Southern-Winds.pdf (Southern and GIT 2007).

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NRC000035	A. Kugler; K. Cort	U.S. Department of Energy, Energy Information Administration, Annual Energy Outlook 2010, DOE/EIA-0383, Tables A9 and 90 (2010), *available at* http://www.eia.doe.gov/oiaf/archive/aeo10/index.html (ML111170385) (DOE/EIA 2010a).
NRC000036	A. Kugler; K. Cort	U.S. Department of Energy, Office of Energy Efficiency & Renewable Energy, 2008 Solar Technologies Market Report (2010), *available at* http://www1.eere.energy.gov/library/asset_handler.aspx?src=http://www1.eere.energy.gov/solar/pdfs/46025.pdf&id=4129 (DOE/EERE 2010).
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NRC000040	A. Kugler; K. Cort	Samir Succar & Robert H. Williams, Princeton University: Energy Systems Analysis Group, Compressed Air Energy Storage: Theory, Resources, and Applications for Wind Power (2008), *available at* http://www.princeton.edu/~ssuccar/caesReport.html (Succar and Williams 2008).
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NRC000042	A. Kugler; K. Cort	Alison M. Conner & James E. Francfort, Idaho National Engineering and Environmental Laboratory, U.S. Hydropower Resource Assessment for Maryland DOE/ID-10430(MD) (1997) (Conner and Francfort 1997).

Calvert Cliffs 3 Nuclear Project and UniStar Nuclear Operating Services
Docket No. 52-016-COL
January 2012 Evidentiary Hearing

UniStar Hearing Exhibits

Exhibit No.	Witness/Panel	Title
APL000001	Lutchenkov/Ratti/ van der Linden	Testimony of Dimitri Lutchenkov, Stefano Ratti, and Septimus van der Linden, dated October 21, 2011
APL000002	Lutchenkov/Ratti/ van der Linden	Affidavit of Dimitri Lutchenkov, dated October 21, 2011 (includes statement of professional qualifications)
APL000003	Lutchenkov/Ratti/ van der Linden	Affidavit of Stefano Ratti, dated October 21, 2011 (includes statement of professional qualifications)
APL000004	Lutchenkov/Ratti/ van der Linden	Affidavit of Septimus van der Linden, dated October 21, 2011 (includes statement of professional qualifications)
APL000005	Lutchenkov/Ratti/ van der Linden	Exeter Associates, Inc., “Long-Term Electricity Report for Maryland,” Prepared for the Maryland Department of Natural Resources, September 23, 2011
APL000006	Lutchenkov/Ratti/ van der Linden	David Roberts , “Answer to cheap power is blowing in offshore wind: Atlantic Wind Connection sees hundreds of miles of turbines making efficient energy,” May 10, 2011
APL000007	Lutchenkov/Ratti/ van der Linden	National Renewable Energy Laboratory, “Large-Scale Offshore Wind Power in the United States – Assessment of Opportunities and Barriers,” 2010
APL000008	Lutchenkov/Ratti/ van der Linden	Department of Energy, Lawrence Berkley National Laboratory, “2009 Wind Technologies Market Report,” 2009
APL000009	Lutchenkov/Ratti/ van der Linden	GE Energy Energy Consulting, “The Effects of Integrating Wind Power on Transmission System Planning, Reliability, and Operations,” Prepared for the New York State Energy Research and Development Authority, March 4, 2005
APL000010	Lutchenkov/Ratti/ van der Linden	University of Delaware’s Center for Carbon-free Power Integration, College of Earth, Ocean, and Environment, “Maryland’s Offshore Wind Power Potential,” February 1, 2010

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APL000011	Lutchenkov/Ratti/ van der Linden	New York State Energy Research & Development Authority, "Wind Power Project Site – Identification and Land Requirements," October 2005
APL000012	Lutchenkov/Ratti/ van der Linden	Ridge Energy Storage & Grid Services L.P., "The Economic Impact of CAES on Wind in TX, OK, and NM, Final Report," Prepared for: Texas State Energy Conservation Office, June 27, 2005
APL000013	Lutchenkov/Ratti/ van der Linden	John Blau, "Oversupply Causes Drop in Wind Turbine Prices," October 10, 2011
APL000014	Lutchenkov/Ratti/ van der Linden	Department of Energy, Energy Information Administration, DOE/EIA-0383, "Annual Energy Outlook 2011," Table 1, December 2010
APL000015	Lutchenkov/Ratti/ van der Linden	"Deepwater to build first U.S. offshore wind farm," Reuters, October 14, 2011
APL000016	Lutchenkov/Ratti/ van der Linden	"2 Mass. utilities make very different power deals," Associated Press, March 27, 2011
APL000017	Lutchenkov/Ratti/ van der Linden	Duke Energy, "2010-2011 Sustainability Report," Another Strong Year for Renewables, 2011
APL000018	Lutchenkov/Ratti/ van der Linden	Wind Energy News, "Duke Energy Axes North Carolina Offshore Wind Pilot," August 20, 2010
APL000019	Lutchenkov/Ratti/ van der Linden	National Wind Coordinating Committee, "Permitting of Wind Energy Facilities," August 2002
APL000020	Lutchenkov/Ratti/ van der Linden	Department of the Interior, "Frequently Asked Questions: 'Smart from the Start' Atlantic OCS Offshore Wind Initiative," 2010
APL000021	Lutchenkov/Ratti/ van der Linden	Department of the Interior Press Release, "Salazar Launches 'Smart from the Start' Initiative to Speed Offshore Wind Energy Development off the Atlantic Coast," November 23, 2010
APL000022	Lutchenkov/Ratti/ van der Linden	Bureau of Ocean Energy Management, Regulation, and Enforcement, "Fact Sheet: Renewable Energy on the Outer Continental Shelf," 2011

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APL000023	Lutchenkov/Ratti/ van der Linden	Department of the Interior Press Release, "Salazar Signs First U.S. Offshore Commercial Wind Energy Lease with Cape Wind Associates, LLC," December 6, 2010
APL000024	Lutchenkov/Ratti/ van der Linden	National Renewable Energy Laboratory, "United States Wind Resource Map," 2009
APL000025	Lutchenkov/Ratti/ van der Linden	National Renewable Energy Laboratory, "Estimates of Windy Land Area and Wind Energy Potential, by State, for areas >= 30% Capacity Factor at 80 meters," Feb. 4, 2010 (Updated April 13, 2011 to add Alaska and Hawaii)
APL000026	Lutchenkov/Ratti/ van der Linden	Septimus van der Linden, Technical Paper Presentation, IMECE 2007-41853, "Integrating Wind Turbine Generators (WTGs) with GT-CAES (Compressed Air Energy Storage) stabilizes power delivery with the inherent benefits of Bulk Energy Storage," November 2007
APL000027	Lutchenkov/Ratti/ van der Linden	Maryland State Administration, "Maryland Offshore Wind Energy Act," 2011
APL000028	Lutchenkov/Ratti/ van der Linden	Statement of Gov. O'Malley to American Wind Energy Association, October 11, 2011
APL000029	Lutchenkov/Ratti/ van der Linden	Constellation Energy, "Criterion Wind Project, Garret County, Maryland" (accessed October 20, 2011)
APL000030	Lutchenkov/Ratti/ van der Linden	Gestamp Wind, "Roth Rock," 2011
APL000031	Lutchenkov/Ratti/ van der Linden	American Wind Energy Association, "Wind Energy Facts: Pennsylvania," August 2011
APL000032	Lutchenkov/Ratti/ van der Linden	American Wind Energy Association, "Wind Energy Facts: West Virginia," August 2011
APL000033	Lutchenkov/Ratti/ van der Linden	American Wind Energy Association, "Wind Energy Facts: Virginia," August 2011
APL000034	Lutchenkov/Ratti/ van der Linden	Highland New Wind Farm Development, LLC, "Our Vision" (Accessed October 20, 2011)

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APL000035	Lutchenkov/Ratti/ van der Linden	US Windforce, "Dans Mountain" (Accessed October 21, 2011)
APL000036	Lutchenkov/Ratti/ van der Linden	Department of the Interior Press Release, "Interior Initiates Process for First "Smart from the Start" Lease for Commercial Wind Power Offshore Delaware," March 24, 2011
APL000037	Lutchenkov/Ratti/ van der Linden	New England Opportunities, Inc. et. al., "Report on Final Power Purchase Agreement between Delmarva Power and Bluewater Wind Delaware LLC," July 3, 2008
APL000038	Lutchenkov/Ratti/ van der Linden	American Wind Energy Association, "Wind Power and Energy Storage," 2011
APL000039	Lutchenkov/Ratti/ van der Linden	Department of Energy, National Renewable Energy Laboratory, "2008 Solar Technologies Market Report," January 2010
APL000040	Lutchenkov/Ratti/ van der Linden	Department of Energy Solar Energies Technology Program, "The Prospect for $1/Watt Electricity from Solar," August 10, 2010
APL000041	Lutchenkov/Ratti/ van der Linden	Constellation Energy – Emmitsburg Solar, "Constellation Energy to Develop Maryland's Largest Solar Photovoltaic Power System," 2011
APL000042	Lutchenkov/Ratti/ van der Linden	SREC Trade, "SREC Market Prices," 2011
APL000043	Lutchenkov/Ratti/ van der Linden	Solar Energy Industries Association, "Utility-Scale Solar Projects in the United States Operating, Under Construction, or Under Development," October 14, 20114
APL000044	Lutchenkov/Ratti/ van der Linden	Septimus van der Linden: "APS (American Physics Society) Energy Study Working Group-Study on Electricity Storage," August 14th, 2006
APL000045	Lutchenkov/Ratti/ van der Linden	Septimus van der Linden, "Review of CAES Systems Development and current Innovations that could bring commercialization to fruition," EESAT 2007
APL000046	Lutchenkov/Ratti/ van der Linden	Septimus van der Linden, "Bulk Energy Storage Potential in the USA, Current Developments & Future Prospects," 17th International Conference on Efficiency, Costs, Optimization, of Simulation and Environmental Impact of Energy Process Systems, ECOS 2004

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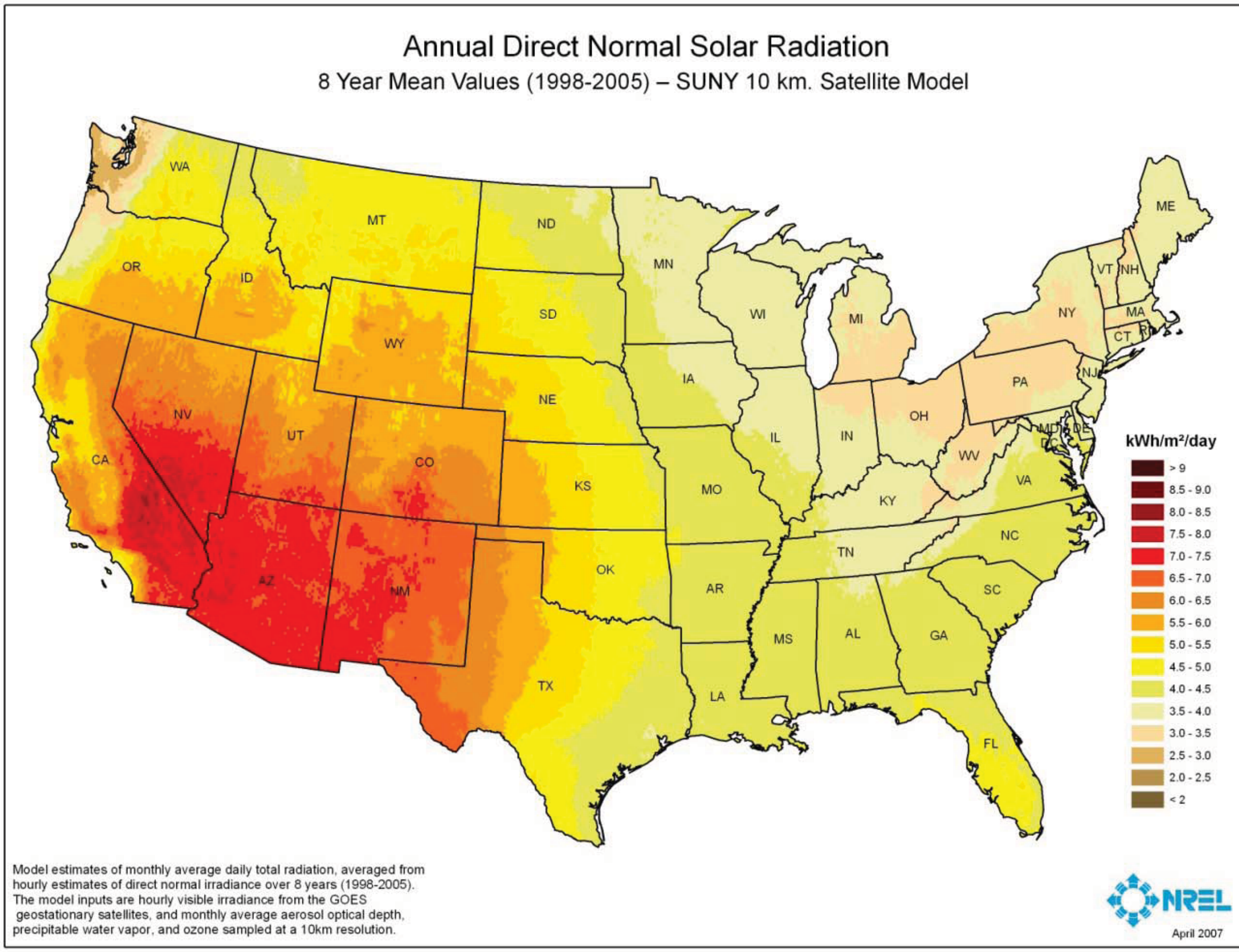
APL000047	Lutchenkov/Ratti/ van der Linden	Fritz Crotogino et al., "Grid Scale Energy Storage in Salt Caverns," 2011
APL000048	Lutchenkov/Ratti/ van der Linden	Calvert Cliffs Power Plant Unit 3 COLA (Environmental Report), Rev. 7 - Chapter 09, Alternatives to the Proposed Action, Sections 9.1 and 9.2, December 20, 2010 (ADAMS Accession No. ML103620413)
APL000049	Lutchenkov/Ratti/ van der Linden	Septimus van der Linden, "Hard Rock Caverns-Limestone and Other," March 2011
APL000050	Lutchenkov/Ratti/ van der Linden	"Environmental Impact Statement for the Combined License (COL) for Calvert Cliffs Nuclear Power Plant Unit 3, Draft Report for Comment," Sections 9.1 and 9.2, NUREG-1936 (April 2010) (ADAMS Accession Nos. ML101000012 and ML101000013)
APL000051	Lutchenkov/Ratti/ van der Linden	Jürgen Kepplinger et al., "Present Trends in Compressed Air Energy and Hydrogen Storage in Germany," SMRI Fall Technical Conference, October 3-4, 2011
APL000052	Lutchenkov/Ratti/ van der Linden	Iowa Store Energy Park Press Release, "Iowa Stored Energy Park Project Terminated," July 28, 2011
APL000053	Lutchenkov/Ratti/ van der Linden	Chris Bullough et al., "Advanced Adiabatic Compressed Air Energy Storage for the Integration of Wind Energy," Proceedings of the European Wind Energy Conference, November 2004
APL000054	Lutchenkov/Ratti/ van der Linden	Septimus van der Linden, "Integrating Wind Turbine Generators (WTGs) with GT-CAES (Compressed Air Energy Storage) stabilizes power delivery with the inherent benefits of Bulk Energy Storage," IMECE 2007-41853, November 2007


Annual Direct Normal Solar Radiation
8 Year Mean Values (1998-2005) – SUNY 10 km. Satellite Model
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Model estimates of monthly average daily total radiation, averaged from
hourly estimates of direct normal irradiance over 8 years (1998-2005).
The model inputs are hourly visible irradiance from the GOES
geostationary satellites, and monthly average aerosol optical depth,
precipitable water vapor, and ozone sampled at a 10km resolution.
NREL
April 2007

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of Docket No. 52-016

Calvert Cliffs-3 Nuclear Power Plant
Combined Construction and License Application

TESTIMONY OF MICHAEL MARIOTTE, EXECUTIVE DIRECTOR OF NUCLEAR INFORMATION AND RESOURCE SERVICE, ON CONTENTION 10

Q.1. Please state your name and describe your professional qualifications to give this testimony.

My name is Michael Mariotte and I am Executive Director of Nuclear Information and Resource Service (NIRS). I began work at NIRS in February 1985 and became Executive Director in October 1986. In that capacity, I have testified numerous times before U.S. Senate and House committees; before the Maryland State Legislature on Calvert Cliffs issues and the need for the state of Maryland to implement renewable energy and energy efficiency measures to replace the power of the existing Unit 1 and 2 reactors at Calvert Cliffs when they retire; before the Washington, DC Public Service Commission against the proposed merger of Pepco and Baltimore Gas & Electric (BG&E) due to the exposure to nuclear power that such a merger would cause Pepco as well as the inadequacy of BG&E's renewable and energy efficiency measures; before the Hungarian Parliament; before the Bulgarian Nuclear Safety Agency; before the U.S. Nuclear Regulatory Commission and numerous other official and non-official conferences, meetings and other functions in the U.S. and Greece, Ukraine, and Germany . I have been a guest lecturer at for-credit classes at the University of Delaware and Franklin & Marshall College (as recently as October 11, 1011) on nuclear power and sustainable energy issues. I frequently lecture on the viability and current status of renewable energy technologies and have throughout my tenure at NIRS.

Q.2. What is the purpose of your testimony?

The purpose of my testimony is to discuss my views on Joint Intervenors Contention 10, which argues that the Environmental Impact Statement for the proposed Calvert Cliffs-3 nuclear reactor does not adequately consider the potential contribution of solar and wind power to Maryland and the surrounding PJM grid which allocates power to Maryland and surrounding states as alternatives to the proposed Calvert Cliffs-3 nuclear reactor.

Q.3. Why do you believe that the Environmental Impact Statement prepared for the proposed Calvert Cliffs-3 nuclear reactor does not adequately consider the potential contribution of solar and wind power to Maryland and the larger PJM grid that services Maryland with electricity?

First, I should point out that Contention 10, as admitted by the Atomic Safety and Licensing Board, is essentially a contention of omission—that the Applicants, in preparation of their Environmental Report, and the NRC staff, in preparation of their Environmental Impact Statement, which is based in part upon the Applicants' Environmental Report, have not adequately considered the potential contribution of solar and wind power as an alternative to construction of the Calvert Cliffs-3 nuclear reactor.

As a contention of omission, the burden is on the Applicants and the NRC staff to show that they have indeed met the requirements of the National Environmental Policy Act and that the Environmental Impact Statement does, in fact, adequately consider the potential contributions of wind and solar power as alternatives to Calvert Cliffs-3.

As Joint Intervenors showed in their initial contention and have continued to demonstrate in documents submitted during discovery during this proceeding, Applicants and NRC staff have consistently understated the potential contributions of solar and wind power to Maryland and the larger PJM grid, thus leading to a skewed portrait of those potential contributions.

Q.4. How does the EIS for Calvert Cliffs-3 understate the potential contribution of wind power to Maryland the larger PJM grid that services Maryland?

The Environmental Impact Statement for Calvert Cliffs-3 continues to perpetuate the fiction that offshore wind power potential for Maryland is roughly equivalent to that of Georgia.

In fact, according to a June 2010 report from the U.S. Department of Energy's National Renewable Energy Laboratory, *Assessment of Offshore Wind Energy Resources for the United States*, easily accessible offshore wind power (that within three nautical miles of land) for Maryland is 4,289.80 Megawatts of power—far more than the 1,600 MW of power the proposed Calvert Cliffs-3 reactor would generate.[1] Even granting nuclear power's greater efficiency over wind (approx. 85% capacity vs. 30% capacity) this offshore wind potential is nearly that of the proposed Calvert Cliffs-3 reactor even before other alternatives are thrown into the mix

[1] Joint Intervenors' Exhibit JNT 000001

By comparison, Georgia has a total of 85.2 MW of power potential from offshore wind located with three nautical miles of land. Clearly, this statement by NRC was meant to mislead, rather than clarify, the debate over the potential offshore wind contribution to Maryland's, and the PJM's, electricity mix.

Indeed, the EIS assumes only 100 MW of wind power contribution in its discussion of alternatives to Calvert Cliffs-3, and notes that this would equal approximately 250-300 MW of installed capacity.[2]

The EIS further states, on the same page, that generation of this magnitude is not currently being proposed in Maryland, which is false.

Further down the same page, the EIS argues that quadrupling the amount of possible wind power, to 400 MW (installed capacity of 1000-1200 MW) would not materially change its assessment.

As noted above, the actual potential for easily accessible offshore wind power, off the rather small Maryland coast alone, is about four times that acknowledged by the NRC—more than 4,000 MW (according to NREL, more than 6500 MW of offshore wind is available off the Maryland coast from 3-50 miles offshore, but since this large potential is not even needed to support this contention, we are only referencing it, rather than relying upon it as part of the wind potential).

Bluewater Wind, a subsidiary of NRG Energy—contrary to representations in the EIS—already is proposing to build a 600 MW wind farm offshore of Maryland.[3] This single project, which would tap wind resources more than 12 miles from land, would itself provide four times the amount of wind power initially examined in the EIS, and ½ or more of the amount the EIS argues would not change its assessment.

In addition, Bluewater Wind has received approval to build a 450 MW wind farm off the coast of Delaware and is proposing to build another 350 MW off the coast of New Jersey, both of which would feed into the PJM grid that services Maryland. With these projects alone, which only scratch the surface of potential wind power in Maryland and the region, the power produced would exceed that considered in the Calvert Cliff-3 EIS. The actual potential for wind power in this small region is far greater—on the order of thousands of megawatts, as indicated by Joint Intervenors Exhibit 000001.

While this discussion is so far limited to offshore wind, we note that there are also onshore wind projects in Maryland, which, while generally smaller in scale, do contribute to the overall wind power potential for Maryland.

Q.5. How does the EIS for Calvert Cliffs-3 reactor understand the potential contribution of solar power to Maryland and the PJM grid that services Maryland.

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[2] EIS for Calvert Cliffs-3, NUREG-1936, May 2011, p. 9-28
[3] http://www.nrgenergy.com/nrgbluewaterwind/maryland.html

The EIS considers a potential contribution of a maximum of 75 MW of solar power as an alternative to Calvert Cliffs-3 in the EIS. This is far, far lower than the actual potential contribution.

The EIS concentrates on solar power plants, which Joint Intervenors agree are not a generally viable alternative at this time and could produce little more than 75 MW. But the EIS vastly underestimates (essentially providing zero credit for) the potential contribution of rooftop and other above-ground solar photovoltaics.

A map of solar power potential[4] in the U.S. at first appears to show little solar potential for Maryland, at least compared to some other states in the southwestern U.S. However, the second most solar-state in the U.S. (i.e., the state with the second-most installed solar capacity as of October 2011) is New Jersey, which already has 260 MW of installed solar capacity, or more than three times that assumed by the EIS.[5] And New Jersey has by no means maximized its solar potential.

As the DOE map of solar potential indicates, Maryland actually has slightly better solar potential than New Jersey. Germany, which has the highest solar generation capacity in the world, actually has a lower solar potential than Maryland or New Jersey. Germany currently has 17,000 MW of solar power installed, and expects to install at least 52,000 MW and possibly more than 70,000 MW of solar power by 2020[6]—approximately the same time frame in which the proposed Calvert Cliffs-3 reactor could possibly be built.

Moreover, given that the PJM grid services the mid-Atlantic region, the total solar potential for the region is above that.

Costs of solar power, particularly solar PV power, have been dropping dramatically. This is perhaps best illustrated by the recent bankruptcy of the Solyndra firm, which had developed a new form of solar PV technology, which cost approximately $3,000/kw to manufacture, and which could not compete with existing solar PV firms which are providing solar PV technology of approximately $1,000-$1,500/kw—or about one third to one-sixth the stated cost (in the EIS) of the proposed Calvert Cliffs-3 nuclear reactor. Given this wide disparity in costs for technologies that provide the same end good—electricity—it is not surprise that solar power is the fastest growing source of electricity production in the U.S.

What is surprising is that the EIS completely fails to recognize this trend and suggests—erroneously—that solar PV will provide no power whatsoever to Maryland and the PJM grid during the 60-year period in which Calvert Cliffs-3 would operate. This is simply an untenable omission of the facts. Indeed, it would not be at all surprising if solar PV alone provides more electricity to Maryland and the PJM grid than Calvert Cliffs-3 could when it could first come online, not to mention even a small fraction of its potential lifespan—

[4] JNT000002
[5] http://www.energycentral.com/functional/news/news_detail.cfm?did=22031623
[6] http://www.solarnovus.com/index.php?option=com_content&view=article&id=2591:intersolar-europe-2011-new-exhibit-of-german-solar-potential&catid=41:applications-tech-news&Itemid=245

i.e. within 10-20 years after coming online. And an EIS should consider, if it is to be meaningful, not just the likely situation when a nuclear reactor first comes online, but also the likely situation after the reactor has operated for a period of time. In this case, the EIS fails on both accounts.

Q.6. Can solar and wind power provide "baseload" power?

An underlying conceit of the EIS and Applicants' Environmental Report is that technologies like solar and wind power can not provide "baseload" power and thus are somehow to be substantially discounted as to their potential contribution to the electrical needs of a state or region.

This line of argument certainly would have been relevant some years ago; it is much less relevant in 2011.

The notion of "baseload" power has changed radically from the late 20th century.

Calvert Cliffs-3 is indeed intended to be a "baseload" power plant. However, because of electricity deregulation, the operators of Calvert Cliffs-3 can only sell their electricity to those entities that wish to purchase power from Calvert Cliffs-3. This reactor would only be a "baseload" power source to the extent that there are willing power purchasers for its electricity.

If, as Joint Intervenors believe, a completed Calvert Cliffs-3 would provide electricity too expensive for most people to purchase, then Calvert Cliffs-3 would not be a baseload power plant in the traditional sense of the word, but would instead be a "boutique" power plant selling high-priced power to whoever wants it (we note that in the record of this proceeding, the estimated cost of Calvert Cliffs-3 would be on the order of $4,500/kw to $6,000/kw, far above competing sources of electricity generation). In terms of providing "baseload" power for Maryland and the PJM service territory, Joint Intervenors argue that the extraordinary costs of building Calvert Cliffs-3 would preclude it from ever becoming part of the "baseload" for Maryland or the PJM region.

Moreover, in the time frame of this reactor license application, which realistically at this point assumes commercial operation no earlier than 2020, one must also consider the likely advances of technology (as opposed to fanciful advances in technology)--in other words, those advances which are likely to play a major role in our lives and decision-making.

In the case of this contention, the concept of storage for renewably-generated electricity is given short shrift. While the EIS does mention the concept of Compressed Air Energy Storage technology, it gives it short shrift and assumes that by 2020 and beyond to 2080—the period in which this reactor would be licensed—that the technology will not advance to a commercially applicable stage. Yet no rationale is provided for this assertion that CAES technology will not be commercially viable before Calvert Cliff-3 could even come online, much less operate for some years.

Similarly, the EIS does not address the potential of smart grids and distributed generation to allow a new vision of electricity distribution, one that is not as reliant on large, centralized power plants, but rather relies on dispersed, smaller, but perhaps more secure power stations—typically but not necessarily powered by renewable resources—that can meet our electrical needs. Solar and wind power, as our contention argues, are the most powerful technology candidates for this type of energy future, which is just as, and Joint Intervenors argue is much more so, economically viable as a proposed large nuclear reactor such as Calvert Cliffs-3.

Beyond the economic arguments over Calvert Cliffs-3, however, is the simple reality that wind and solar power, especially coupled with modern grid practices, is far more able to meet Maryland's, and the entire mid-Atlantic's, electricity needs that is given credit for in the Calvert Cliffs-3 EIS and can provide needed power on a much more flexible basis.

In the context of the EIS, substantial contribution can also be granted to natural gas (although Joint Intervenors believe no such contribution is necessary). Indeed, Joint Intervenors believe and argue that natural gas should be considered only a back-up power source to renewable power generation, which can meet the needs of Maryland in the time frame of 2020. While such back-up power may be needed on occasion, it will be the power of last resort, rather than of first resort.

Joint Intervenors essentially agree with both Applicants and NRC staff on the future need for electricity in Maryland and the PJM service area (although we believe aggressive energy efficiency programs, such as those instituted by the state of Maryland, can reduce electricity demand more than given credit for in the EIS). However, we believe there are many different possible paths to generating and making that electricity available to Maryland and mid-Atlantic consumers.

The EIS for the proposed Calvert Cliffs-3 nuclear reactor does not recognize this simple reality, and does not effectively counter this simple reality. It does not adequately take into account the potential contributions of solar and wind power in Maryland or the entire region, and thus fails to provide a legally-defensible picture of the situation. As such, the EIS much be rejected as written and must be re-researched, re-written, and re-submitted before the proposed Calvert Cliffs-3 nuclear reactor can be considered for licensing.

Respectfully submitted,

This 21st day of October 2011
________Signed Electronically by________________

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CERTIFICATE OF SERVICE

It is our understanding that all on the Calvert Cliffs-3 service list are receiving this motion through the submission I am making on October 3, 2011 via the EIE system.

JOINT INTERVENORS TESTIMONY, OCTOBER 21, 2011

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