Information Request AG 6-1

Request:

Please refer to Exhibit-NG-JNC-Rebuttal-1, Figure 2, at page 10.
a. Provide all back-up, workpapers and analyses in a functional spreadsheet format that support this chart.

b. Expand this chart using annual values for each year of the Black & Veatch projection.

c. Calculate the energy margins that would accrue to a new combined cycle gas turbine with a 6.450 MMBtu/MWh heat rate for each year assuming 100% capacity factor.

Response:

a-c. Please see Attachment AG-6-1(a) (Highly Sensitive Confidential Information). Additional graphs can be generated from this data.

REDACTED

Column	A	B	C	D	F	G
Line #	Year	Energy Prices, $/MWh	Gas, $/MMBtu	CO2, $/ton	Implied Heat Rate, Btu/kWh	Energy Margins, $ @ 750 MW @ 100% CF
1	2010	[redacted]				
2	2011					
3	2012					
4	2013					
5	2014					
6	2015					
7	2016					
8	2017					
9	2018					
10	2019					
11	2020					
12	2021					
13	2022					
14	2023					
15	2024					
16	2025					
17	2026					
18	2027					
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22	2031					
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24	2033					
25	2034					
26	2035					
27	2036					
28	2037					
29	2038					

REDACTED

Column	A	B	C	D	F	G
Line #	Year	Energy Prices, $/MWh	Gas, $/MMBtu	CO2, $/ton	Implied Heat Rate, Btu/kWh	Energy Margins, $ @ 750 MW @ 100% CF
30						
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Column	A	B	C	D	F	G
Line #	Year	Energy Prices, $/MWh	Gas, $/MMBtu	CO2, $/ton	Implied Heat Rate, Btu/kWh	Energy Margins, $ @ 750 MW @ 100% CF
63						
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Column	A	B	C	D	F	G
Line #	Year	Energy Prices, $/MWh	Gas, $/MMBtu	CO2, $/ton	Implied Heat Rate, Btu/kWh	Energy Margins, $ @ 750 MW @ 100% CF
96						
97						
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Column	A	B	C	D	F	G
Line #	Year	Energy Prices, $/MWh	Gas, $/MMBtu	CO2, $/ton	Implied Heat Rate, Btu/kWh	Energy Margins, $ @ 750 MW @ 100% CF
129						
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Column	A	B	C	D	F	G
Line #	Year	Energy Prices, $/MWh	Gas, $/MMBtu	CO2, $/ton	Implied Heat Rate, Btu/kWh	Energy Margins, $ @ 750 MW @ 100% CF
162						
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Column	A	B	C	D	F	G
Line #	Year	Energy Prices, $/MWh	Gas, $/MMBtu	CO2, $/ton	Implied Heat Rate, Btu/kWh	Energy Margins, $ @ 750 MW @ 100% CF
195						
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Column	A	B	C	D	F	G
Line #	Year	Energy Prices, $/MWh	Gas, $/MMBtu	CO2, $/ton	Implied Heat Rate, Btu/kWh	Energy Margins, $ @ 750 MW @ 100% CF
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Column	A	B	C	D	F	G
Line #	Year	Energy Prices, $/MWh	Gas, $/MMBtu	CO2, $/ton	Implied Heat Rate, Btu/kWh	Energy Margins, $ @ 750 MW @ 100% CF
261						
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Column	A	B	C	D	F	G
Line #	Year	Energy Prices, $/MWh	Gas, $/MMBtu	CO2, $/ton	Implied Heat Rate, Btu/kWh	Energy Margins, $ @ 750 MW @ 100% CF
294						
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Column	A	B	C	D	F	G
Line #	Year	Energy Prices, $/MWh	Gas, $/MMBtu	CO2, $/ton	Implied Heat Rate, Btu/kWh	Energy Margins, $ @ 750 MW @ 100% CF
327						
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Column	H	I	J	K	L	M
Line #	Year	Month	Energy Prices, $/MWh	Gas, $/MMBtu	CO2, $/ton	Implied Heat Rate, Btu/kWh
1	2010	1	[redacted]			
2	2010	2				
3	2010	3				
4	2010	4				
5	2010	5				
6	2010	6				
7	2010	7				
8	2010	8				
9	2010	9				
10	2010	10				
11	2010	11				
12	2010	12				
13	2011	1				
14	2011	2				
15	2011	3				
16	2011	4				
17	2011	5				
18	2011	6				
19	2011	7				
20	2011	8				
21	2011	9				
22	2011	10				
23	2011	11				
24	2011	12				
25	2012	1				
26	2012	2				
27	2012	3				
28	2012	4				
29	2012	5				

Column	H	I	J	K	L	M
Line #	Year	Month	Energy Prices, $/MWh	Gas, $/MMBtu	CO2, $/ton	Implied Heat Rate, Btu/kWh
30	2012	6	[redacted]			
31	2012	7				
32	2012	8				
33	2012	9				
34	2012	10				
35	2012	11				
36	2012	12				
37	2013	1				
38	2013	2				
39	2013	3				
40	2013	4				
41	2013	5				
42	2013	6				
43	2013	7				
44	2013	8				
45	2013	9				
46	2013	10				
47	2013	11				
48	2013	12				
49	2014	1				
50	2014	2				
51	2014	3				
52	2014	4				
53	2014	5				
54	2014	6				
55	2014	7				
56	2014	8				
57	2014	9				
58	2014	10				
59	2014	11				
60	2014	12				
61	2015	1				
62	2015	2				

Column	H	I	J	K	L	M
Line #	Year	Month	Energy Prices, $/MWh	Gas, $/MMBtu	CO2, $/ton	Implied Heat Rate, Btu/kWh
63	2015	3	[redacted]			
64	2015	4				
65	2015	5				
66	2015	6				
67	2015	7				
68	2015	8				
69	2015	9				
70	2015	10				
71	2015	11				
72	2015	12				
73	2016	1				
74	2016	2				
75	2016	3				
76	2016	4				
77	2016	5				
78	2016	6				
79	2016	7				
80	2016	8				
81	2016	9				
82	2016	10				
83	2016	11				
84	2016	12				
85	2017	1				
86	2017	2				
87	2017	3				
88	2017	4				
89	2017	5				
90	2017	6				
91	2017	7				
92	2017	8				
93	2017	9				
94	2017	10				
95	2017	11				

Column	H	I	J	K	L	M
Line #	Year	Month	Energy Prices, $/MWh	Gas, $/MMBtu	CO2, $/ton	Implied Heat Rate, Btu/kWh
96	2017	12	[redacted]			
97	2018	1				
98	2018	2				
99	2018	3				
100	2018	4				
101	2018	5				
102	2018	6				
103	2018	7				
104	2018	8				
105	2018	9				
106	2018	10				
107	2018	11				
108	2018	12				
109	2019	1				
110	2019	2				
111	2019	3				
112	2019	4				
113	2019	5				
114	2019	6				
115	2019	7				
116	2019	8				
117	2019	9				
118	2019	10				
119	2019	11				
120	2019	12				
121	2020	1				
122	2020	2				
123	2020	3				
124	2020	4				
125	2020	5				
126	2020	6				
127	2020	7				
128	2020	8				

Column	H	I	J	K	L	M
Line #	Year	Month	Energy Prices, $/MWh	Gas, $/MMBtu	CO2, $/ton	Implied Heat Rate, Btu/kWh
129	2020	9	[redacted]			
130	2020	10				
131	2020	11				
132	2020	12				
133	2021	1				
134	2021	2				
135	2021	3				
136	2021	4				
137	2021	5				
138	2021	6				
139	2021	7				
140	2021	8				
141	2021	9				
142	2021	10				
143	2021	11				
144	2021	12				
145	2022	1				
146	2022	2				
147	2022	3				
148	2022	4				
149	2022	5				
150	2022	6				
151	2022	7				
152	2022	8				
153	2022	9				
154	2022	10				
155	2022	11				
156	2022	12				
157	2023	1				
158	2023	2				
159	2023	3				
160	2023	4				
161	2023	5				

Column	H	I	J	K	L	M
Line #	Year	Month	Energy Prices, $/MWh	Gas, $/MMBtu	CO2, $/ton	Implied Heat Rate, Btu/kWh
162	2023	6	[redacted]			
163	2023	7				
164	2023	8				
165	2023	9				
166	2023	10				
167	2023	11				
168	2023	12				
169	2024	1				
170	2024	2				
171	2024	3				
172	2024	4				
173	2024	5				
174	2024	6				
175	2024	7				
176	2024	8				
177	2024	9				
178	2024	10				
179	2024	11				
180	2024	12				
181	2025	1				
182	2025	2				
183	2025	3				
184	2025	4				
185	2025	5				
186	2025	6				
187	2025	7				
188	2025	8				
189	2025	9				
190	2025	10				
191	2025	11				
192	2025	12				
193	2026	1				
194	2026	2				

Column	H	I	J	K	L	M
Line #	Year	Month	Energy Prices, $/MWh	Gas, $/MMBtu	CO2, $/ton	Implied Heat Rate, Btu/kWh
195	2026	3	[redacted]			
196	2026	4				
197	2026	5				
198	2026	6				
199	2026	7				
200	2026	8				
201	2026	9				
202	2026	10				
203	2026	11				
204	2026	12				
205	2027	1				
206	2027	2				
207	2027	3				
208	2027	4				
209	2027	5				
210	2027	6				
211	2027	7				
212	2027	8				
213	2027	9				
214	2027	10				
215	2027	11				
216	2027	12				
217	2028	1				
218	2028	2				
219	2028	3				
220	2028	4				
221	2028	5				
222	2028	6				
223	2028	7				
224	2028	8				
225	2028	9				
226	2028	10				
227	2028	11				

Column	H	I	J	K	L	M
Line #	Year	Month	Energy Prices, $/MWh	Gas, $/MMBtu	CO2, $/ton	Implied Heat Rate, Btu/kWh
228	2028	12	[redacted]			
229	2029	1				
230	2029	2				
231	2029	3				
232	2029	4				
233	2029	5				
234	2029	6				
235	2029	7				
236	2029	8				
237	2029	9				
238	2029	10				
239	2029	11				
240	2029	12				
241	2030	1				
242	2030	2				
243	2030	3				
244	2030	4				
245	2030	5				
246	2030	6				
247	2030	7				
248	2030	8				
249	2030	9				
250	2030	10				
251	2030	11				
252	2030	12				
253	2031	1				
254	2031	2				
255	2031	3				
256	2031	4				
257	2031	5				
258	2031	6				
259	2031	7				
260	2031	8				

Column	H	I	J	K	L	M
Line #	Year	Month	Energy Prices, $/MWh	Gas, $/MMBtu	CO2, $/ton	Implied Heat Rate, Btu/kWh
261	2031	9	[redacted]			
262	2031	10				
263	2031	11				
264	2031	12				
265	2032	1				
266	2032	2				
267	2032	3				
268	2032	4				
269	2032	5				
270	2032	6				
271	2032	7				
272	2032	8				
273	2032	9				
274	2032	10				
275	2032	11				
276	2032	12				
277	2033	1				
278	2033	2				
279	2033	3				
280	2033	4				
281	2033	5				
282	2033	6				
283	2033	7				
284	2033	8				
285	2033	9				
286	2033	10				
287	2033	11				
288	2033	12				
289	2034	1				
290	2034	2				
291	2034	3				
292	2034	4				
293	2034	5				

Column	H	I	J	K	L	M
Line #	Year	Month	Energy Prices, $/MWh	Gas, $/MMBtu	CO2, $/ton	Implied Heat Rate, Btu/kWh
294	2034	6	[redacted]			
295	2034	7				
296	2034	8				
297	2034	9				
298	2034	10				
299	2034	11				
300	2034	12				
301	2035	1				
302	2035	2				
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305	2035	5				
306	2035	6				
307	2035	7				
308	2035	8				
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311	2035	11				
312	2035	12				
313	2036	1				
314	2036	2				
315	2036	3				
316	2036	4				
317	2036	5				
318	2036	6				
319	2036	7				
320	2036	8				
321	2036	9				
322	2036	10				
323	2036	11				
324	2036	12				
325	2037	1				
326	2037	2				

Column	H	I	J	K	L	M
Line #	Year	Month	Energy Prices, $/MWh	Gas, $/MMBtu	CO2, $/ton	Implied Heat Rate, Btu/kWh
327	2037	3	[redacted]			
328	2037	4				
329	2037	5				
330	2037	6				
331	2037	7				
332	2037	8				
333	2037	9				
334	2037	10				
335	2037	11				
336	2037	12				
337	2038	1				
338	2038	2				
339	2038	3				
340	2038	4				
341	2038	5				
342	2038	6				
343	2038	7				
344	2038	8				
345	2038	9				
346	2038	10				
347	2038	11				
348	2038	12				

Information Request AG 6-2

Request:

Please refer to Exhibit-NG-JNC-Rebuttal-1, Figure 3, at page 11.
a. Provide all back-up, workpapers and analyses in a functional spreadsheet format that support this chart.

b. Expand this chart using the same month values for each year of the Black & Veatch projection.

Response:

Please see Attachment AG-6-1(a) (Highly Sensitive Confidential Information). Additional graphs can be generated from this data.

Information Request AG 6-3

Request:

Please refer to Exhibit-NG-JNC-Rebuttal-1, Figure 4, at page 12.
a. Provide all back-up, workpapers and analyses in a functional spreadsheet format that support this chart.

b. Expand this chart using the same winter month values for each year of the Black & Veatch projection.

c. Provide this chart using only December, January and February for each historic year plus each year of the Black & Veatch projection.

Response:

Please see Attachment AG-6-1(a) (HIGHLY SENSITIVE CONFIDENTIAL INFORMATION). Additional graphs can be generated from this data.

Information Request AG 6-4

Request:

Please describe the process that Black & Veatch uses to determine which plants to retire in a long-term forecast and produce the functional model and/or model results for the Black & Veatch model runs relied upon by Mr. Copeland.

Response:

Black & Veatch does not perform an economic analysis to determine retirements, but rather uses age-based retirements. Therefore, there is no functional model used for this analysis. Black & Veatch provided the capacity values, by type, by year, for the analysis period in Attachment NEER-1-4(a).

Information Request AG 6-5

Request:

Please describe the process that Black & Veatch uses to determine how many new plants (i.e., "generic units") need to be built and produce the functional spreadsheet and/or model results for the Black & Veatch model runs relied upon by Mr. Copeland.

Response:

Black & Veatch uses reserve margin equilibrium to determine when a new entry will enter the market. At that specific point in time, using the capital and fixed costs, the model evaluates several different types of units to determine which unit(s) produces the lowest residual fixed cost. The buildout of generic units and their timing of entry have been previously provided in Attachment AG-4-1(a) (Highly Sensitive Confidential Information).

Information Request AG 6-6

Request:

Please confirm that the electricity prices Black & Veatch is producing using PROMOD represents the ISO-NE energy market and does not include payments for capacity that would be generated by the ISO-NE Forward Capacity Market.

Response:

The prices developed by PROMOD represent the ISO-NE Energy Market only and do not include payment for capacity that would be generated by the ISO-NE Forward Capacity Market.

Information Request AG 6-7

Request:

See the response to Information Request AG-NG-4-3(a). Please respond to this question with respect to how ANE was modeled, using specific nodes and arcs represented in GPCM.
a. Please describe, using references specific to GPCM, how ANE was modeled in the Black & Veatch projection.

b. Describe the specific "nodes" and "arc" where incremental capacity is added (see GPCM description at https://rbac.com/gpcm-natural-gas-market-model-description/):

Mathematically, GPCM is a network model. It can be diagrammed as a set of "nodes" and "arcs". Nodes represent production regions, pipeline zones and interconnects, storage facilities, delivery points, and customers or customer groups. The connections between these nodes are called "arcs". They represent transactions and flows. Some of these are supplier deliveries to pipelines, transportation across zones and from one zone to another, transfers of gas by one pipeline to another, delivery of gas into storage, storage of gas from one period to another, withdrawal of gas from storage, and pipeline deliveries of gas to customers.

c. Provide the four input attributes and two output attributes associated with the "arc" that was added to represent ANE in GPCM (see GPCM description at https://rbac.com/gpcm-natural-gas-market-model-description/):

In general an arc has four input attributes and two output attributes. The inputs are cost (which may depend on transaction volume), a minimum, a maximum, and a loss factor (representing fuel use and miscellaneous losses). The outputs are the amount of the transaction (the flow) and the economic rent associated with the flow. The latter is defined mathematically as the economic value of a unit increase (decrease) in the upper (lower) bound. It generally applies to pipeline transportation and storage capacity and represents the marginal value of increased capacity.
d. Describe how much capacity was added to represent ANE and Acushnet.

e. Provide a map of the nodes and arcs modeled in GPCM and indicate where ANE additional delivery capacity is modeled.

f. Provide the prices projected by GPCM at the "nodes" and/or either end of the "arc" to which ANE capacity is model.

Response:

a) Black & Veatch modeled the ANE projected based on the information provided in the RFP. On page B-10, Table 1 of the ANE RFP provides the receipt point capacity and deliverability by aggregation area as modeled in the GPCM model. On page B-8 of the ANE RFP provides the assumptions for LNG storage facility in Acushnet, MA.

b) Black & Veatch added the pipeline interconnects, segments, and storage as described above in part a and shown in part e.

c) Please see response to Information Request AG-6-9 (Highly Sensitive Confidential Information) for the relevant cost assumptions for the ANE project, and please see Attachment AG-1-42(a) (Highly Sensitive Confidential Information) for the resulting flows.

d) Please refer to Part a.

e) Please see Figure 8 on page C-2 for the map of the aggregation areas modeled in the GPCM.

f) Black & Veatch has provided all relevant regional gas prices used in the analysis in Attachment NEER-1-3(a) (Highly Sensitive Confidential Information).

Information Request AG 6-8

Request:

Please see the description provided in the London Economics Incorporated study prepared for the Maine PUC referenced by Ms. Bodell in her direct testimony (Exhibit AG-TB-5). Please provide the equivalent description of GPCM model used by Black & Veatch with specification of the assumptions that were provided by London Economics in Appendix A at pages 52-67.

Response:

Black & Veatch has provided the relevant assumptions used in GPCM analysis specified in the Exhibit AG-TB-5, pages 52-67 in the following responses and attachments.

Please see Attachment AG-4-8(b) (Highly Sensitive Confidential Information) for the Nova Scotia Offshore Production Projections and Attachment CLF-1-18(a) (Highly Sensitive Confidential Information) for the monthly New England gas demand projections.

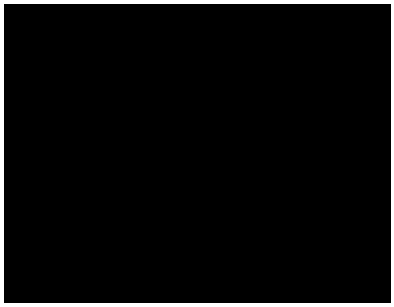
Information Request AG 6-9

Request:

Please see your response to Information Request AG-4-4 and reference the London Economics study (Exhibit AG-TB-5), Figure 38, at page 58. Please provide the specification of the transportation curve used to represent ANE.

Response:

Please see below the representative transportation curve assumptions used for ANE.



Prepared by or under the supervision of: Joseph Neil Copeland and Denny K. Yeung

Information Request AG 6-10

Request:

Please see response to Information Request AG-2-3. Please explain why the gas demand for power generation from 2013 through 2040 is "nearly identical" with and without ANE.

Response:

Black & Veatch believes that the proper reference is Exhibit AG-2-13. Black & Veatch did not change the electric supply and demand assumptions between the "with ANE" and "without ANE" scenarios. Since ISO-NE is primarily a gas-driven market, there is very little shift in the type of electric supply resources that serve the electric demand.

Information Request AG 6-11

Request:

Please list all prior projects that Mr. Copeland has directed that uses GPCM combined with a production cost model such as PROMOD.

Response:

Mr. Copeland has directed numerous confidential client engagements utilizing Black & Veatch's Energy Market Perspective which utilizes the GPCM and PROMOD production cost model. Mr. Copeland was a key contributor to Black & Veatch's study for NESCOE.