

Quadrennial Review Issues

MIC - Quadrennial Review
May 19, 2025

IMM



Monitoring Analytics

Overview of IMM CONE Review Process

- **Monitoring Analytics, LLC (“MA”) retained Pasteris Energy, Inc. to develop the revenue requirements of a new entrant (“CONE”) combustion turbine (“CT”) and combined cycle (“CC”) power plant located in five (5) PJM Locational Deliverability Areas (“LDA”) on a 2028 dollar basis for commercial operation in the 2028-2029 capacity year as part of the PJM RPM 2024 Quad-Review.**



Overview of IMM CONE Review Process

- **Stantec Consulting Services, Inc. (“Stantec”) a power plant design and engineering firm with CT and CC plant design experience was contracted by Pasteris Energy, Inc. to determine the plant proper capital cost estimate for the CONE CT and CC power plant at the five locations within PJM.**
- **Stantec assembled these estimates based upon recent major equipment CT and CC Power Island cost quotes from GE and balance of plant (“BOP”) equipment quotations.**

GE quotes obtained April 21, 2025.



Overview of IMM CONE Review Process

- **The power plant construction estimates were developed based on data from recent actual construction proposals by Stantec and input obtained from multiple construction contractors. For these estimates labor rates and labor productivity for each CONE Area were verified and used to develop the direct and indirect construction costs. The plant proper estimate is an engineering, procurement and construction (“EPC”) turnkey cost estimate in overnight mid-year 2024 dollars.**



CT Unit Details

Model	GE Frame 7HA.03 CT
Description	CT with evaporative coolers, wet compression, SCR for NOx reduction, CO converter, and dual fuel capability
Configuration	1 × 0
Dual-Fuel Capability	Yes
Firm Gas Transportation Contract	No
ICAP by CONE Area (MW)	438 / 435 / 425 / 432 / 427
Net Heat Rate (Btu/kWh)	9,065
Equivalent Availability Factor (EAF)	88.9%



CT Gross CONE Comparison

\$ in millions	IMM CT Capital Costs Dual Fuel - GE Frame 7HA.03 (2024\$)				
	EMAAC	SWMAAC	Rest of RTO	WMAAC	COMED
ICAP (MW)	438	435	425	432	427
Owner Furnished Equipment (OFE)	\$225	\$225	\$225	\$225	\$225
EPC Costs	\$200	\$177	\$186	\$185	\$209
OFE + EPC Costs	\$424	\$402	\$410	\$410	\$434
Electric Interconnect/System Upgrades	\$14	\$13	\$13	\$13	\$14
Gas Interconnect	\$20	\$19	\$20	\$20	\$21
Equipment Spares	\$7	\$7	\$7	\$7	\$7
Initial Fuel and Other Inventory	\$5	\$5	\$5	\$5	\$5
Mobilization and Startup	\$3	\$3	\$3	\$3	\$3
Land Purchase/Land Reservation Payment	\$3	\$1	\$1	\$1	\$2
Development Expenses	\$8	\$8	\$8	\$8	\$8
Legal Fees	\$3	\$3	\$3	\$3	\$3
Permits	\$3	\$3	\$3	\$3	\$3
Emission Reduction Credits	\$43	\$43	\$1	\$1	\$1
Financing Fees	\$6	\$5	\$5	\$5	\$5
Owner's Contingency	\$11	\$10	\$10	\$10	\$11
Sales Tax	\$1	\$1	\$0	\$0	\$1
Net Start Up Fuel	-	-	-	-	-
Non-EPC Costs	\$125	\$120	\$78	\$78	\$82
Total Project Overnight Cost (2024\$)	\$549	\$522	\$488	\$488	\$516
Total Project Overnight Cost 2024 (\$/kW)	\$1,253	\$1,201	\$1,149	\$1,128	\$1,209
Total Project Overnight Cost (2028\$)	\$552	\$525	\$490	\$490	\$518
Total Project Overnight Cost 2028 (\$/kW)	\$1,259	\$1,208	\$1,154	\$1,133	\$1,214
Total Project Installed Cost (2028\$)	\$607	\$577	\$542	\$541	\$572
Total Project Installed Cost 2028 (\$/kW)	\$1,385	\$1,328	\$1,275	\$1,251	\$1,341

	Brattle CT Capital Costs Dual Fuel - GE Frame 7HA.03 (2028\$)				
	EMAAC	SWMAAC	Rest of RTO	WMAAC	COMED
	392	395	387	383	393
	\$212	\$212	\$212	\$212	\$212
	\$226	\$208	\$209	\$216	\$247
	\$438	\$420	\$421	\$427	\$473
	\$22	\$22	\$22	\$22	\$22
	\$35	\$35	\$35	\$35	\$35
	\$2	\$2	\$2	\$2	\$2
	\$4	\$4	\$4	\$4	\$4
	\$4	\$4	\$4	\$4	\$5
	\$1	\$1	\$0	\$1	\$1
	\$22	\$21	\$21	\$21	\$24
	\$0	\$0	\$0	\$0	\$0
	\$0	\$0	\$0	\$0	\$0
	\$12	\$11	\$11	\$11	\$13
	\$7	\$7	\$7	\$7	\$8
	\$0	\$0	\$0	\$0	\$0
	(\$1)	\$0	(\$2)	(\$3)	\$1
	\$109	\$108	\$105	\$105	\$114
	-	-	-	-	-
	-	-	-	-	-
	\$547	\$528	\$526	\$532	\$587
	\$1,395	\$1,339	\$1,361	\$1,390	\$1,495
	\$672	\$651	\$648	\$655	\$722
	\$1,715	\$1,647	\$1,674	\$1,710	\$1,837

CT Fixed O&M Comparison

\$ in millions	IMM CT Fixed O&M - GE Frame 7HA.03 (2024\$)				
	EMAAC	SWMAAC	Rest of RTO	WMAAC	COMED
Site O&M Labor	\$2.2	\$2.1	\$2.1	\$2.1	\$2.1
O&M Contract Parts and Labor	\$0.7	\$0.7	\$0.7	\$0.7	\$0.7
LTSA Fixed Fee	\$0.5	\$0.5	\$0.5	\$0.5	\$0.5
O&M Management Fees	\$0.2	\$0.2	\$0.2	\$0.2	\$0.2
Electric Purchases	\$0.4	\$0.4	\$0.4	\$0.4	\$0.4
Employee Training Expenses	\$0.1	\$0.1	\$0.1	\$0.1	\$0.1
Insurance	\$2.3	\$2.2	\$2.3	\$2.3	\$2.4
General and Administrative Expenses	\$0.3	\$0.3	\$0.3	\$0.3	\$0.3
Property Taxes	\$1.5	\$1.5	\$0.4	\$0.4	\$0.6
Other	-	-	-	-	-
Total Fixed O&M	\$8.3	\$8.0	\$7.1	\$7.0	\$7.3

	IMM CT Variable O&M (2028\$)				
	EMAAC	SWMAAC	Rest of RTO	WMAAC	COMED
Major Maintenance - Starts Based (\$/Start)	-	-	-	-	-
Consumables, Waste Disposal, Other VOM (\$/MWh)	\$0.4	\$0.4	\$0.4	\$0.4	\$0.4
Major Maintenance (\$/MWh)	\$4.9	\$4.9	\$4.9	\$4.9	\$4.9

	Brattle CT Fixed O&M - GE Frame 7HA.03 (2028\$)				
	EMAAC	SWMAAC	Rest of RTO	WMAAC	COMED
	\$1.2	\$1.3	\$0.9	\$1.0	\$1.1
	\$0.5	\$0.5	\$0.5	\$0.5	\$0.5
	\$0.5	\$0.5	\$0.5	\$0.5	\$0.5
	\$0.6	\$0.7	\$0.5	\$0.5	\$0.6
	-	-	-	-	-
	-	-	-	-	-
	\$3.3	\$3.2	\$3.2	\$3.2	\$3.5
	\$0.3	\$0.3	\$0.3	\$0.3	\$0.3
	\$0.5	\$6.7	\$3.4	\$0.6	\$0.5
	\$0.2	\$0.2	\$0.2	\$0.2	\$0.2
	\$7.0	\$13.2	\$9.2	\$6.8	\$7.2

	Brattle CT Variable O&M (2028\$)				
	EMAAC	SWMAAC	Rest of RTO	WMAAC	COMED
	\$33,007	\$33,007	\$33,007	\$33,007	\$33,007
	\$1.1	\$1.1	\$1.0	\$1.1	\$1.1
	-	-	-	-	-



CT Gross and Net CONE Comparison

	IMM CT Levelized Revenue Requirement (2028\$)				
	EMAAC	SWMAAC	Rest of RTO	WMAAC	COMED
Gross CONE w/o major maintenance (\$/MW-Day)	\$552	\$529	\$505	\$496	\$532
Forward EAS, MM in VOM (\$/MW-Day)	\$158	\$310	\$361	\$323	\$215
Net CONE (\$/MW-Day)	\$395	\$219	\$144	\$172	\$317

	IMM CT Levelized Revenue Requirement (2028\$)				
	EMAAC	SWMAAC	Rest of RTO	WMAAC	COMED
Gross CONE w/ major maintenance (\$/MW-Day)	\$674	\$640	\$561	\$547	\$628
3yr Hist EAS, SRMC, Scaled Fwd (\$/MW-Day)	\$159	\$281	\$389	\$362	\$249
Net CONE (\$/MW-Day)	\$515	\$359	\$172	\$185	\$379

	Brattle CT Levelized Revenue Requirement (2028\$)				
	EMAAC	SWMAAC	Rest of RTO	WMAAC	COMED
Gross CONE w/o major maintenance (\$/MW-Day)	\$670	\$676	\$663	\$664	\$789
Forward EAS, MM in VOM (\$/MW-Day)	\$76	\$228	\$254	\$191	\$108
Net CONE (\$/MW-Day)	\$593	\$449	\$409	\$473	\$681

	Brattle CT Levelized Revenue Requirement (2028\$)				
	EMAAC	SWMAAC	Rest of RTO	WMAAC	COMED
Gross CONE w/ major maintenance (\$/MW-Day)	-	-	-	-	-
3yr Hist EAS, SRMC, Scaled Fwd (\$/MW-Day)	-	-	-	-	-
Net CONE (\$/MW-Day)	-	-	-	-	-

IMM forwards as of January 10, 2025.
IMM did not limit the CT to 40% capacity factor.

CC Unit Details

Model	GE Frame 7HA.03 CC
Description	Each CC with a single CT, HRSG, and steam turbine, equipped with CT evaporative cooler and wet compression, SCR for NOx reduction, CO converter, air cooled condensers, duct burners, and dual fuel capability
Configuration	2 trains of 1×1 single shaft
Dual-Fuel Capability	Yes
Firm Gas Transportation Contract	No
ICAP by CONE Area (MW)	1,420 / 1,411 / 1,385 / 1,406 / 1,390
Net Heat Rate (Btu/kWh)	6,564
Equivalent Availability Factor (EAF)	84.4%



CC Gross CONE Comparison

\$ in millions	IMM CC Capital Costs Dual Fuel - GE Frame 7HA.03 (2024\$)				
	EMAAC	SWMAAC	Rest of RTO	WMAAC	COMED
ICAP (MW)	1,420	1,411	1,385	1,406	1,390
Owner Furnished Equipment (OFE)	\$567	\$567	\$567	\$567	\$567
EPC Costs	\$1,044	\$895	\$952	\$946	\$1,135
OFE + EPC Costs	\$1,611	\$1,462	\$1,519	\$1,513	\$1,703
Electric Interconnect/System Upgrades	\$40	\$36	\$37	\$37	\$42
Gas Interconnect	\$28	\$26	\$27	\$27	\$30
Water and Sewer Connection	\$8	\$7	\$7	\$7	\$8
Equipment Spares	\$12	\$12	\$12	\$12	\$12
Initial Fuel and Other Inventory	\$10	\$10	\$10	\$10	\$10
Mobilization and Startup	\$7	\$6	\$7	\$7	\$7
Land Purchase/Land Reservation Payment	\$9	\$5	\$3	\$4	\$7
Development Expenses	\$11	\$11	\$11	\$11	\$11
Legal Fees	\$3	\$3	\$3	\$3	\$3
Permits	\$4	\$4	\$4	\$4	\$4
Emission Reduction Credits	\$105	\$105	\$5	\$5	\$5
Financing Fees	\$20	\$18	\$18	\$18	\$20
Owner's Contingency	\$40	\$37	\$38	\$38	\$43
Sales Tax	\$2	\$2	\$2	\$2	\$2
Net Start Up Fuel	-	-	-	-	-
Non-EPC Costs	\$300	\$281	\$183	\$183	\$203
Total Project Overnight Cost (2024\$)	\$1,910	\$1,743	\$1,702	\$1,697	\$1,906
Total Project Overnight Cost 2024 (\$/kW)	\$1,345	\$1,236	\$1,229	\$1,207	\$1,371
Total Project Overnight Cost (2028\$)	\$1,932	\$1,762	\$1,719	\$1,702	\$1,925
Total Project Overnight Cost 2028 (\$/kW)	\$1,360	\$1,249	\$1,241	\$1,211	\$1,385
Total Project Installed Cost (2028\$)	\$2,275	\$2,077	\$2,037	\$2,014	\$2,277
Total Project Installed Cost 2028 (\$/kW)	\$1,602	\$1,472	\$1,471	\$1,433	\$1,639

	Brattle CC Capital Costs Firm Gas - GE Frame 7HA.03 (2028\$)				
	EMAAC	SWMAAC	Rest of RTO	WMAAC	COMED
	1,289	1,289	1,276	1,264	1,294
	\$542	\$542	\$542	\$542	\$576
	\$1,142	\$1,013	\$1,014	\$1,066	\$1,255
	\$1,684	\$1,555	\$1,556	\$1,608	\$1,831
	\$72	\$72	\$71	\$70	\$72
	\$49	\$49	\$49	\$49	\$49
	-	-	-	-	-
	\$8	\$8	\$8	\$8	\$9
	-	-	-	-	-
	\$17	\$16	\$16	\$16	\$18
	\$6	\$6	\$3	\$6	\$7
	\$84	\$78	\$78	\$80	\$92
	-	-	-	-	-
	-	-	-	-	-
	\$2	\$2	\$2	\$2	\$2
	\$42	\$39	\$39	\$40	\$46
	\$17	\$17	\$16	\$16	\$19
	-	-	-	-	-
	(\$25)	(\$21)	(\$26)	(\$31)	(\$12)
	\$273	\$265	\$255	\$256	\$302
	-	-	-	-	-
	-	-	-	-	-
	\$1,956	\$1,820	\$1,811	\$1,864	\$2,133
	\$1,517	\$1,411	\$1,419	\$1,476	\$1,649
	\$2,487	\$2,314	\$2,305	\$2,372	\$2,712
	\$1,929	\$1,795	\$1,806	\$1,877	\$2,096

CC Fixed O&M Comparison

\$ in millions	IMM CC Fixed O&M - GE Frame 7HA.03 (2024\$)				
	EMAAC	SWMAAC	Rest of RTO	WMAAC	COMED
Site O&M Labor	\$5.5	\$5.3	\$5.4	\$5.4	\$5.2
O&M Contract Parts and Labor	\$3.6	\$3.3	\$3.4	\$3.4	\$3.8
LTSA Fixed Fee	\$1.1	\$1.1	\$1.1	\$1.1	\$1.1
O&M Management Fees	\$0.4	\$0.4	\$0.4	\$0.4	\$0.4
Electric Purchases	\$0.5	\$0.5	\$0.5	\$0.5	\$0.5
Employee Training Expenses	\$0.2	\$0.2	\$0.2	\$0.2	\$0.2
Insurance	\$8.6	\$7.8	\$8.1	\$8.1	\$9.1
General and Administrative Expenses	\$1.3	\$1.3	\$1.3	\$1.3	\$1.3
Property Taxes	\$5.3	\$5.0	\$2.4	\$2.3	\$3.3
Firm Gas Contract	-	-	-	-	-
Other	\$0.0	\$0.0	\$0.0	\$0.0	\$0.0
Total Fixed O&M	\$26.4	\$24.8	\$22.8	\$22.7	\$24.9

	IMM CC Variable O&M (2028\$)				
	EMAAC	SWMAAC	Rest of RTO	WMAAC	COMED
Major Maintenance - Starts Based (\$/Start)	-	-	-	-	-
Consumables, Waste Disposal, Other VOM (\$/MWh)	\$0.6	\$0.6	\$0.6	\$0.6	\$0.6
Major Maintenance (\$/MWh)	\$2.2	\$2.2	\$2.2	\$2.2	\$2.2

	Brattle CC Fixed O&M - GE Frame 7HA.03 (2028\$)				
	EMAAC	SWMAAC	Rest of RTO	WMAAC	COMED
	\$5.3	\$5.7	\$3.9	\$4.7	\$5.1
	\$7.8	\$8.0	\$7.0	\$7.5	\$7.7
	\$1.1	\$1.1	\$1.1	\$1.1	\$1.1
	\$1.7	\$1.8	\$1.2	\$1.4	\$1.6
	-	-	-	-	-
	-	-	-	-	-
	\$11.7	\$10.9	\$10.9	\$11.2	\$12.8
	\$1.6	\$1.6	\$1.6	\$1.6	\$1.6
	\$3.3	\$22.9	\$12.6	\$4.2	\$3.1
	\$10.7	\$20.4	\$26.2	\$18.7	\$8.6
	\$0.6	\$0.5	\$0.5	\$0.5	\$0.6
	\$44.0	\$73.0	\$65.1	\$50.9	\$42.3

	Brattle CC Variable O&M (2028\$)				
	EMAAC	SWMAAC	Rest of RTO	WMAAC	COMED
	-	-	-	-	-
	\$0.8	\$0.8	\$0.8	\$0.8	\$0.8
	\$1.9	\$1.9	\$1.9	\$1.9	\$1.9



CC Gross and Net CONE Comparison

	IMM CC Levelized Revenue Requirement (2028\$)				
	EMAAC	SWMAAC	Rest of RTO	WMAAC	COMED
Gross CONE w/o major maintenance (\$/MW-Day)	\$648	\$594	\$591	\$581	\$661
Forward EAS, MM in VOM (\$/MW-Day)	\$252	\$437	\$482	\$441	\$320
Net CONE (\$/MW-Day)	\$396	\$157	\$110	\$140	\$341

	IMM CC Levelized Revenue Requirement (2028\$)				
	EMAAC	SWMAAC	Rest of RTO	WMAAC	COMED
Gross CONE w/ major maintenance (\$/MW-Day)	\$679	\$627	\$626	\$615	\$692
3yr Hist EAS, SRMC, Scaled Fwd (\$/MW-Day)	\$261	\$431	\$493	\$454	\$341
Net CONE (\$/MW-Day)	\$418	\$196	\$134	\$161	\$351

	Brattle CC Levelized Revenue Requirement (2028\$)				
	EMAAC	SWMAAC	Rest of RTO	WMAAC	COMED
Gross CONE w/o major maintenance (\$/MW-Day)	\$816	\$819	\$813	\$814	\$953
Forward EAS, MM in VOM (\$/MW-Day)	\$260	\$517	\$516	\$445	\$327
Net CONE (\$/MW-Day)	\$557	\$303	\$298	\$369	\$626

	Brattle CC Levelized Revenue Requirement (2028\$)				
	EMAAC	SWMAAC	Rest of RTO	WMAAC	COMED
Gross CONE w/ major maintenance (\$/MW-Day)	-	-	-	-	-
3yr Hist EAS, SRMC, Scaled Fwd (\$/MW-Day)	-	-	-	-	-
Net CONE (\$/MW-Day)	-	-	-	-	-

IMM forwards as of January 10, 2025.



Gross CONE Comparison

- **Similar overnight capital costs in 2028\$**
- **Brattle Gross CONE is higher than IMM Gross CONE**
 - **\$117-\$257/MW-Day difference for CT**
 - IMM project spend is \$33M in the first 12 months of the project development phase on a total overnight cost of \$552M
 - Brattle project spend is \$234M in the first 12 months of the project development phase on a total project overnight cost of \$547M
 - **\$169-\$293/MW-Day difference for CC**
 - IMM project spend is \$22M in the first 12 months of the project development phase on a total overnight cost of \$1,931M
 - Brattle project spend is \$781M in the first 12 months of the project development phase on a total project overnight cost of \$1,956M

Key Differences in Gross CONE

- **Impact of Accelerated Spend on CONE CT**
 - IMM carrying cost at the 9.5% ATWACC is \$55.1 million over a 37 month total project schedule
 - Brattle carrying cost at the 9.5% ATWACC is \$126.3 million over a slightly longer 44 month total project schedule
- **Impact of Accelerated Spend on CONE CC**
 - IMM carrying cost at the 9.5% ATWACC is \$343.6 million over a 61 month total project schedule
 - Brattle carrying cost at the 9.5% ATWACC is \$530.7 million over a shorter 50 month total project schedule

EAS

- **Option: Historical net revenues**
 - 3 year historical average
- **Option: Scale historical revenues and costs forward**
 - Calculate 3 year history of gross revenues and costs
 - Scale historical gross revenues forward by the ratio of forward LMP prices to historical LMP prices.
 - Scale historical energy costs forward by the ratio of forward gas prices to historical gas prices.
- **Brattle includes major maintenance in dispatch costs**
 - CT: in both start and variable costs
 - CC: in variable costs
- **PJM EAS includes forwards from unknown date plus maximum capacity factor of 40 percent**

Maximum VRR Price

- **Options:**
 - **Net CONE**
 - **1.5x Net CONE**
 - **Gross CONE**
- **Brattle recommendations**
 - **1.5-1.75x Reference Price**
- **Brattle reference price is subjectively defined substitute for clearly defined Net CONE**

Brattle Reference Price Calculation

- “Reference Price” to replace Net CONE
 - Calculate by zone:

Net CONE Calculations					
CT	HA.03 20 yr levelization forward EAS		escalated 2022 HA.02 20 yr levelization forward EAS	escalated 2022 HA.02 20 yr levelization 10 yr hist EAS	
CC	HA.03 20 yr levelization forward EAS	HA.03 15 yr levelization forward EAS	escalated 2022 HA.02 20 yr levelization forward EAS	escalated 2022 HA.02 20 yr levelization 10 yr hist EAS	escalated 2022 HA.02 15 yr levelization 10 yr hist EAS
Battery	20 yr levelization forward EAS				

- Take the median of the nine values
- Take the 33rd percentile of the median values by LDA
- Round

Brattle Reference Price Implications

- Brattle reference price is subjectively defined substitute for clearly defined Net CONE
 - Of the 9 Net CONE calculations, 5 are CC, 3 are CT, 1 is BESS

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	Brattle CT Levelized Revenue Requirement (2028\$)				
	EMAAC	SWMAAC	Rest of RTO	WMAAC	COMED
Gross CONE w/ major maintenance (\$/MW-Day)	-	-	-	-	-
3yr Hist EAS, SRMC, Scaled Fwd (\$/MW-Day)	-	-	-	-	-
Net CONE (\$/MW-Day)	-	-	-	-	-

	Brattle "Reference Price" (2028\$)				
	EMAAC	SWMAAC	Rest of RTO	WMAAC	COMED
Gross CONE w/o major maintenance (\$/MW-Day)	\$600	\$350	\$350	\$425	\$725

IMM forwards as of January 10, 2025.

IMM did not limit the CT to 40% capacity factor.



Reliability Backstop

- **Reliability backstop is a form of cost of service regulation**
 - **Last resort**
 - **Cost of service regulation not consistent with markets**
 - **Form of subsidy**
 - **Cost of service units displacing market units**
- **Reliability backstop triggers per OATT:**
 - **Aggregate PJM market (RTO)**
 - **Three years in a row at less than .99 of reliability requirement, or**
 - **Three years in a row at less than forecast minimum hourly load**

Reliability Backstop

- **Brattle recommends earlier triggering of backstop**
 - **Trigger the backstop after only one year at maximum price**
 - Long term contracts for new supply, 2 to 15 years
 - **Trigger the backstop by LDA**
 - **Trigger the backstop by a “minimum acceptable” reliability level, defined as:**
 - (a) .99 of the Reliability Requirement for the RTO; and
 - (b) volume at the max price for each LDA (approximately .96 to .99 of LDA reliability requirements)
- **Brattle recommendations all result in introduction of cost of service pricing and undermining markets**

Core Issue

- **Broader goal is to address underlying issue/cause of tight supply-demand conditions in the capacity market.**
- **The current conditions are not the result of organic load growth.**
- **The current conditions in the capacity market are almost entirely the result of load additions from data centers, both actual historical and forecast**
- **This is not a reason to introduce cost of service regulation through an accelerated/distorted version of reliability backstop**
- **The solution includes:**
 - **Planning queue for large load additions**
 - **Large new loads should be added only if they can be served reliably**
 - **Requirement for large loads to bring your own generation**

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