December 2022 Effective Load Carrying Capability (ELCC) Report

For Public Use

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Introduction

PJM uses the Effective Load Carrying Capability (ELCC) methodology to calculate the ELCC Class Ratings for ELCC Classes and Accredited Unforced Capacity (AUCAP) values for ELCC Resources. This December 2022 ELCC Report provides background information on the calculation of the above parameters as well as the resulting values for the parameters. For the December 2022 ELCC Report, ELCC Class Ratings are calculated for each delivery year in the period 2023/2024 – 2032/2033 but only 2023/2024, 2025/2026 and 2026/2027 values are binding and applicable to the 2023/2024 Third Incremental Auction, 2025/2026 Base Residual Auction and 2026/2027 Base Residual Auction, respectively (the results for the rest of the delivery years are provided for informational purposes only). Correspondingly, AUCAP values calculated for ELCC Resources using the results in this report only apply to the Third Incremental Auction for delivery year 2023/2024 and the Base Residual Auctions for delivery years 2025/2026 and 2026/2027. The ELCC methodology employed to perform the calculations is documented in PJM Manual 20 (Section 5) and PJM Manual 21A.

Note that throughout this document all references to a year are effectively references to a delivery year. For simplicity, the delivery years are labeled using the year corresponding to the summer season. Therefore, for example, delivery year 2023 refers to delivery year 2023/2024.

Assumptions

Table 1 provides a list of the assumptions used in the December 2022 ELCC calculations.

Table 1: December 2022 ELCC Study Assumptions

Parameter	December 2022 ELCC Study	Basis for Assumption
ELCC Classes (ELCC Classes for which ELCC Class Ratings are calculated)	Onshore Wind, Offshore Wind, Solar Fixed Panel, Solar Tracking Panel, 4-hr Energy Storage, 6-hr Energy Storage, 8-hr Energy Storage, 10-hr Energy Storage, Solar Hybrid Open Loop, Solar Hybrid Closed Loop, Intermittent Hydropower, Landfill Gas Intermittent, Hydro with Non-Pumped Storage	ELCC Classes with members that are expected to offer or provide capacity in the target year are determined based on a vendor's forecast and PJM Interconnection Queue information
ELCC Resources Deployment Forecast	December 2022 vintage	Most recently developed deployment forecast

Historical Weather Delivery Years	2012 – 2021	2012 was the first delivery year with a non-negligible amount of ELCC Resources; 2021 was the most recent delivery year for which ELCC resource performance and load data were available
Weight for each Historical Weather Year (for the calculation of LOLE and ultimately ELCC Class Ratings)	2012: 0.074 2013: 0.090 2014: 0.129 2015: 0.165 2016: 0.090 2017: 0.090 2018: 0.090 2019: 0.074 2020: 0.099 2021: 0.099	Analysis based on actual weather in each of the 10 delivery years and the weather scenarios considered in the 2023 PJM Load Forecast
Hourly Load Scenarios	10,000 (1,000 for each of the 10 Historical Weather Years)	Generate wide range of load scenarios based on the 12 monthly peaks corresponding to each weather scenario in the 2023 PJM Load Forecast
"Behind-the-meter" Solar Forecast	Consistent with 2023 PJM Load Forecast	Consistent with Reliability Requirement calculation
Thermal Unlimited Resources (Unit List)	Consistent with 2022 Reserve Requirement Study (RRS)	Consistent with Reliability Requirement calculation

Thermal Unlimited Resources (Performance: Forced Outages)	Modeled via Monte Carlo using forced outage metrics consistent with 2022 Reserve Requirement Study (RRS). Modeling of winter peak week generator performance and summer ambient derates is consistent with 2022 RRS.	Consistent with Reliability Requirement calculation
Thermal Unlimited Resources (Performance: Planned and Maintenance Outages)	Modeled via deterministic scheduling algorithm using metrics consistent with 2022 Reserve Requirement Study (RRS). Winter peak week modeling consistent with 2022 RRS.	Consistent with Reliability Requirement calculation
Variable Resources	Output shapes developed for each Historical Weather Year based on actual and backcasted output of existing and planned units. The same output shapes are used for the calculations in each year of the 2023 – 2032 period.	Consistent with Historical Weather Years as well as collection of existing and planned units
Solar Hybrid Resources (Open Loop and Closed Loop)	Configuration of these resources in ELCC Model: Storage component: 4-hr duration, 25% of solar hybrid Maximum Facility Output Solar component: tracking panel, 100% of solar hybrid Maximum Facility Output.	ELCC data submission process and PJM Interconnection Queue
Primary Reserves	2,450 MW	Consistent with PJM System Operations
Demand Resources	Consistent with 2023 PJM Load Forecast	Consistent with other planning models

2023, 2025, and 2026 Results: ELCC Class Ratings and Accredited UCAP values

The ELCC Portfolio Rating i.e., the AUCAP value of the entire set of ELCC Resources as a share of the total nameplate, for 2023, 2025, and 2026 are 51%, 46%, and 42%, respectively.

The allocation of the Portfolio ELCC to each of the ELCC Classes for each of the delivery years is performed in accordance with the procedure described in PJM Manual 20, Section 5.6. The resulting ELCC Class Ratings are shown in Table 2.

Table 2: ELCC Class Ratings for 2023/2024 3IA, 2025/2026 BRA and 2026/2027 BRA

ELCC Class	2023/2024 3IA	2025/2026 BRA	2026/2027 BRA
Onshore Wind	15%	15%	13%
Offshore Wind	42%	40%	31%
Solar Fixed Panel	50%	37%	33%
Solar Tracking Panel	61%	51%	45%
4-hr Storage	94%	77%	77%
6-hr Storage	100%	96%	94%
8-hr Storage	100%	100%	100%
10-hr Storage	100%	100%	100%
Solar Hybrid Open Loop - Storage Component	93%	74%	83%
Solar Hybrid Closed Loop - Storage Component	93%	74%	83%
Hydro Intermittent	37%	37%	37%
Landfill Gas Intermittent	63%	63%	64%
Hydro with Non-Pumped Storage*	98%	94%	93%

* PJM performs an ELCC analysis for each individual unit in this class. The value shown in the table is a representative value provided for informational purposes

To illustrate the differences in the December 2022 values relative to the December 2021 values, Table 3 shows a comparison between the 2024/2025 ELCC Class Ratings from the December 2022 report (non-binding because there are no auctions for 2024/2025 scheduled in calendar year 2023) and those from the December 2021 report[1]. The major differences in 2024 ELCC Class Ratings are the increases for the Solar Fixed and Offshore Wind classes and the decrease for Hydro Intermittent. In the case of the Offshore Wind increase and the Hydro Intermittent decrease, the changes are mainly driven by a loss of load risk profile distributed across more Historical Weather Years in the December 2022 study compared to the December 2021; in the case of the Solar Fixed increase, the change is driven by a few larger units in the December 2022 study whose expected output tends to be higher as a share of nameplate than the average Solar Fixed unit and changes to the hourly load scenarios derived from the 2023 PJM Load Forecast.

Table 3: Comparison of 2024 ELCC Class Ratings between December 2022 and December 2021 Reports

ELCC Class	ELCC Class Rating for 2024/2025 (December 2022)	ELCC Class Rating for 2024/2025 (December 2021)	Difference (in percentage points)
Onshore Wind	18%	16%	+2
Offshore Wind	43%	37%	+6
Solar Fixed Panel	45%	36%	+9
Solar Tracking Panel	56%	54%	+2
4-hr Storage	82%	82%	0
6-hr Storage	98%	97%	+1
8-hr Storage	100%	100%	0
10-hr Storage	100%	100%	0
Solar Hybrid Open Loop - Storage Component	85%	82%	+3
Solar Hybrid Closed Loop - Storage Component	85%	82%	+3
Hydro Intermittent	40%	46%	-6
Landfill Gas Intermittent	63%	60%	+3
Hydro with Non-Pumped Storage*	95%	96%	-1

* PJM performs an ELCC analysis for each individual unit in this class. The value shown in the table is a representative value provided for informational purposes

[1] https://www.pjm.com/-/media/planning/res-adeq/elcc/elcc-class-ratings-for-2024-2025.ashx

The Accredited UCAP (AUCAP) values for existing and planned resources for use in the 2023 3IA, 2025 BRA and 2026 BRA are calculated as the product of the respective ELCC Class Ratings from this report, the Performance Adjustment values calculated concurrent with this report and the Effective Nameplate values. AUCAP values and Performance Adjustment values cannot be made public, but are available in Capacity Exchange on a unit-specific basis to the applicable PJM Members.

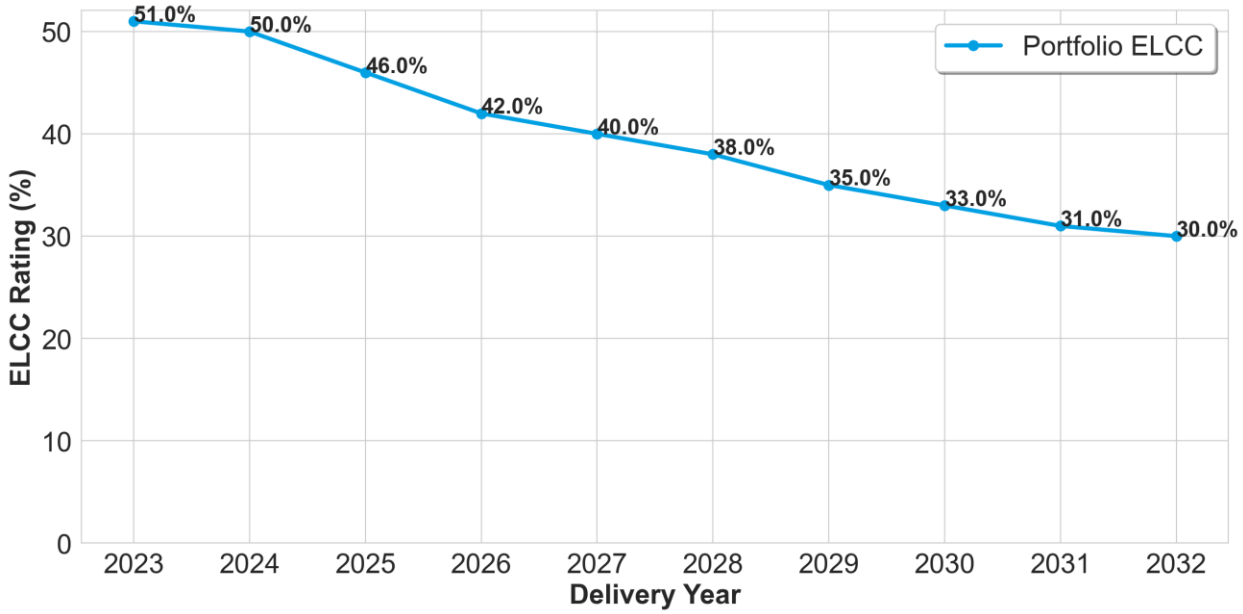
2023 - 2032 Results: ELCC Class Ratings

ELCC Class Ratings are provided for every delivery year in the period 2023 – 2032. Accredited UCAP values, on the other hand, are only available for 2023, 2025 and 2026 as these are the delivery years for which auctions will be held in calendar year 2023. Note that ELCC Class Ratings for delivery years other than 2023, 2025 and 2026 are provided for informational purposes only.

Portfolio of ELCC Resources: 2023 – 2032 ELCC Rating

Figure 1 shows the ELCC Rating of the Portfolio of ELCC Resources (as a share of total nameplate of ELCC Resources) for the period 2023 – 2032. The rating exhibits a marked downward trend as the overall penetration of ELCC Resources increases. Any potential complementarity between some of the ELCC Classes is not sufficient to reverse the downward trend in the ELCC Rating of the Portfolio of ELCC Resources.

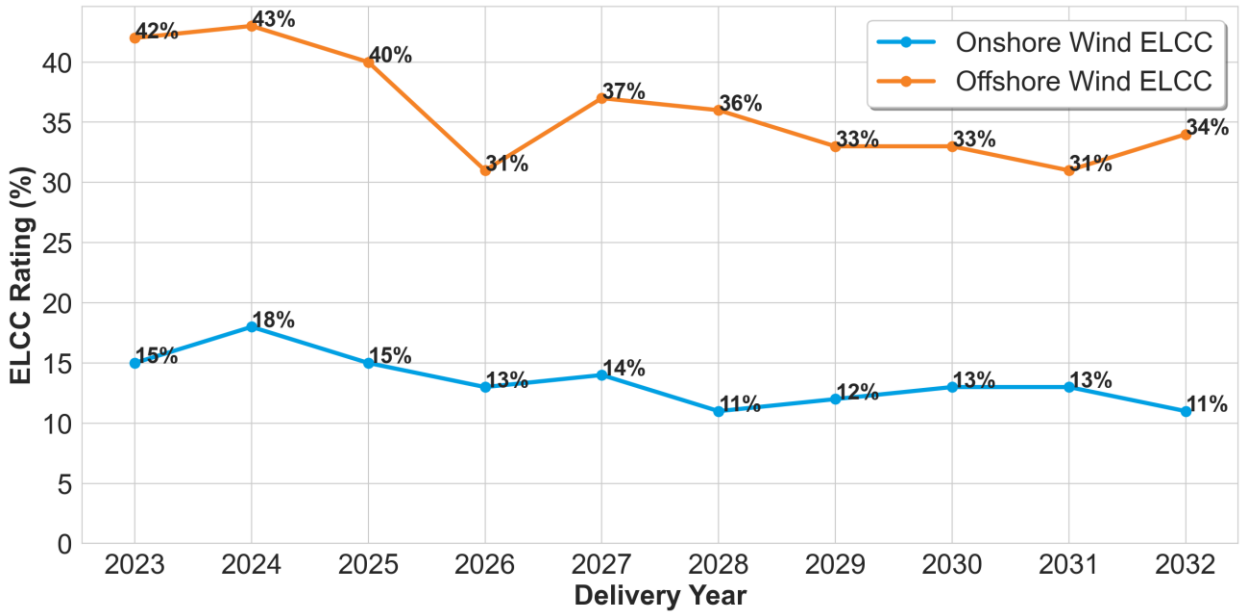
Figure 1: 2023 - 2032 ELCC Portfolio Rating



Onshore Wind & Offshore Wind: 2023 – 2032 ELCC Class Ratings

Figure 2 shows the 2023 – 2032 ELCC Class Ratings for Onshore Wind and Offshore Wind. The ratings for both classes exhibit an overall downward trend.

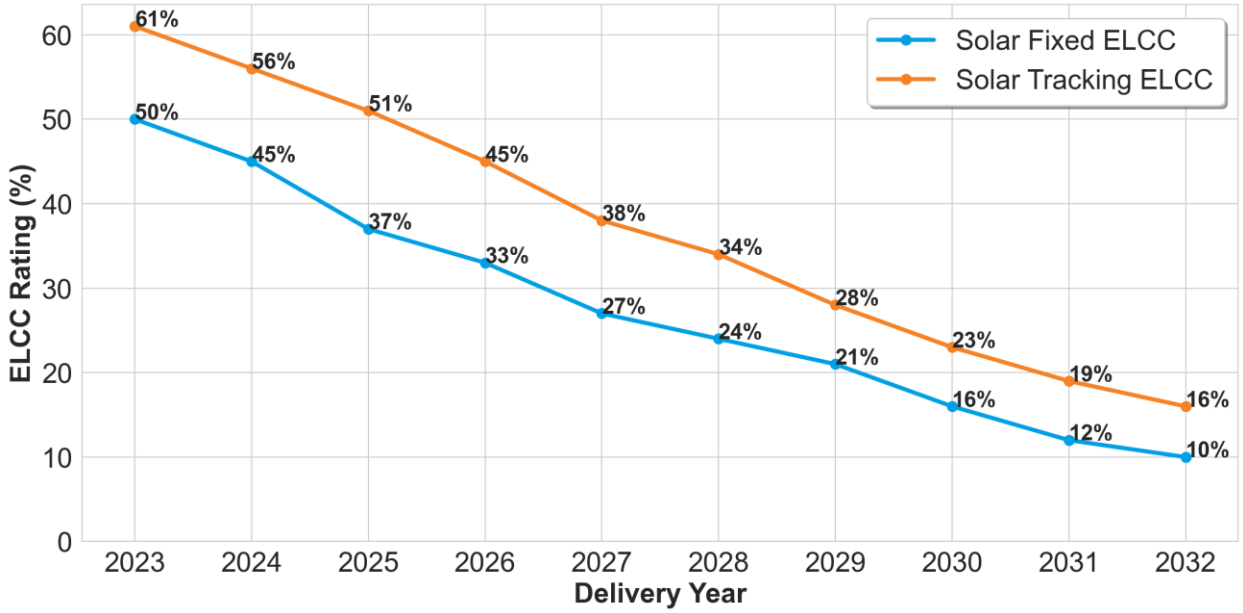
Figure 2: 2023 – 2032 ELCC Class Ratings for Onshore Wind & Offshore Wind



Solar Fixed Panel & Solar Tracking Panel: 2023 – 2032 ELCC Class Ratings

Figure 3 shows the 2023 – 2032 ELCC Class Ratings for Solar Fixed Panel and Solar Tracking Panel. The ratings for both classes exhibit a steep decline as the penetration level of each class increases.

Figure 3: 2023 - 2032 ELCC Class Ratings for Solar Fixed Panel & Solar Tracking Panel

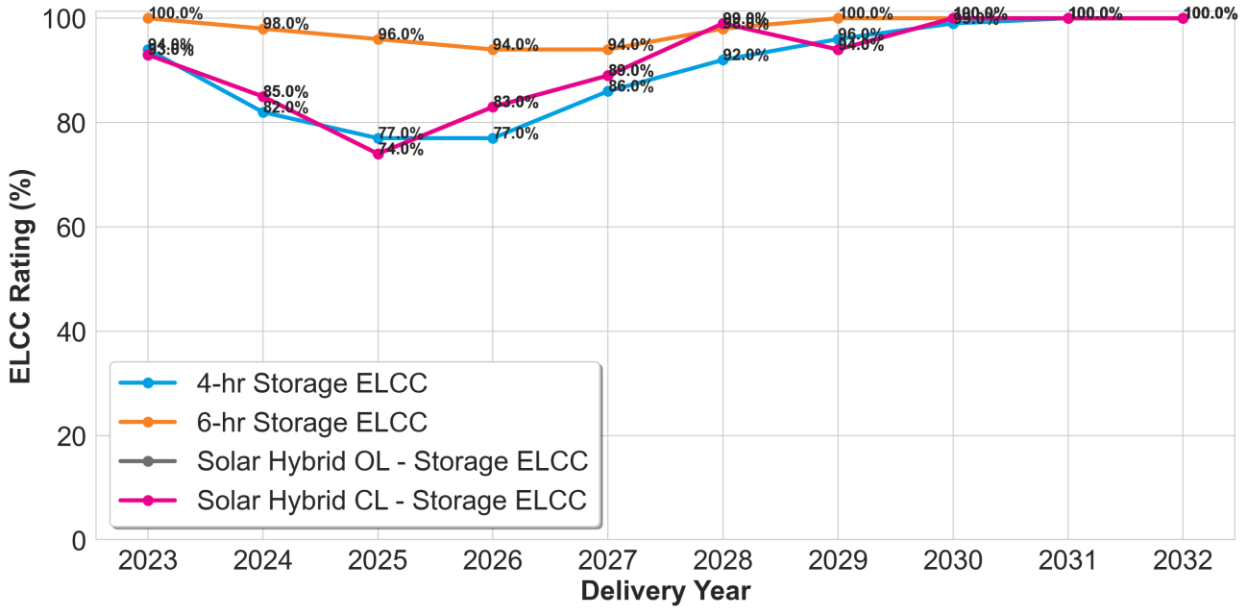


4-hr Storage, 6-hr Storage, Solar Hybrid Open Loop (OL) - Storage Component, Solar Hybrid Closed Loop (CL) - Storage Component: 2023 – 2032 ELCC Class Ratings

Figure 4 shows the 2023 – 2032 ELCC Class Ratings for 4-hr Storage, 6-hr Storage and the Storage Component of Solar Hybrids (for both, open and closed loop). The 6-hr Storage rating exhibits a mild decline until 2026; it then stabilizes around 94% and picks up again in 2028.

A similar pattern of decline and increase in class rating can be observed for 4-hr Storage, though the decline is more pronounced and the rating values are lower than for 6-hr Storage. The ratings for the storage component of open-loop and closed-loop solar hybrids are identical to each other for the entire period (gray line in Figure 4 coincides with the magenta line).

Figure 4: 2023 – 2032 ELCC Class Ratings for 4-hr Storage, 6-hr Storage, Solar Hybrid Open Loop (OL) - Storage Component, Solar Hybrid Closed Loop (CL) - Storage Component

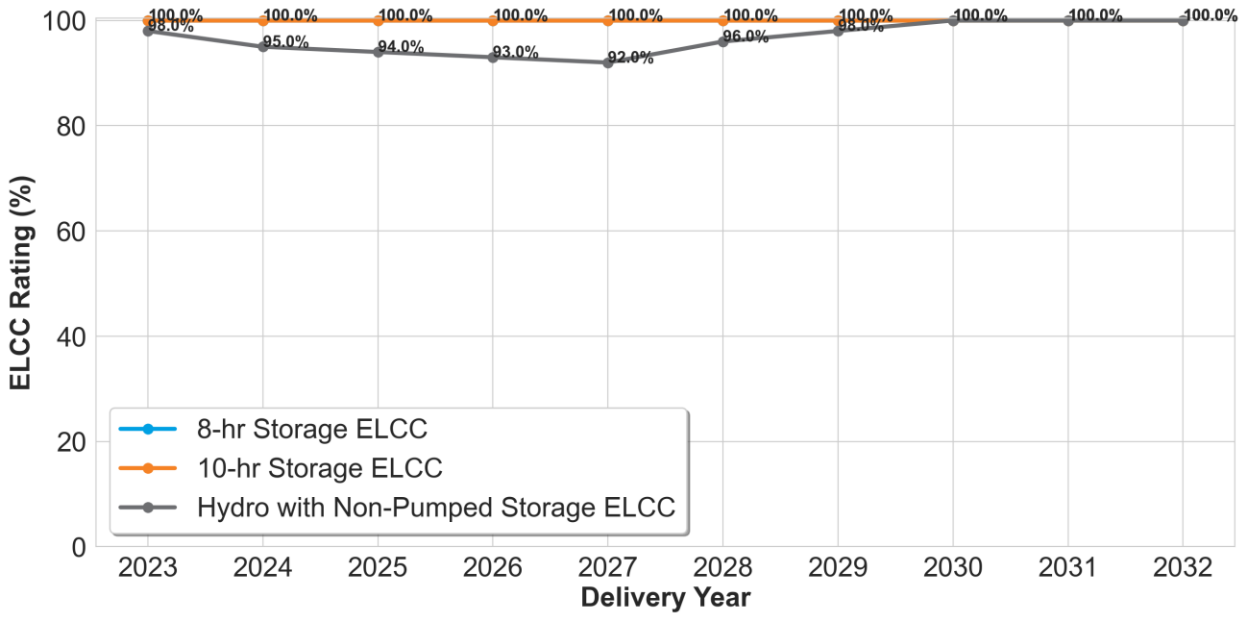


8-hr Storage, 10-hr Storage, Hydro with Non-Pumped Storage: 2023 – 2032 ELCC Class Ratings

Figure 5 shows the 2023 – 2032 ELCC Class Ratings for 8-hr Storage, 10-hr Storage and Hydro with Non-Pumped Storage. The ratings for 8-hr Storage and 10-hr Storage remain constant at 100% for the entire period.

Figure 5 also shows an aggregate rating for the Hydro with Non-Pumped Storage class, notwithstanding the fact that PJM performs an ELCC analysis for each individual unit in this class. The trend for the aggregate rating of this class follows the same pattern as that observed for the classes in Figure 4.

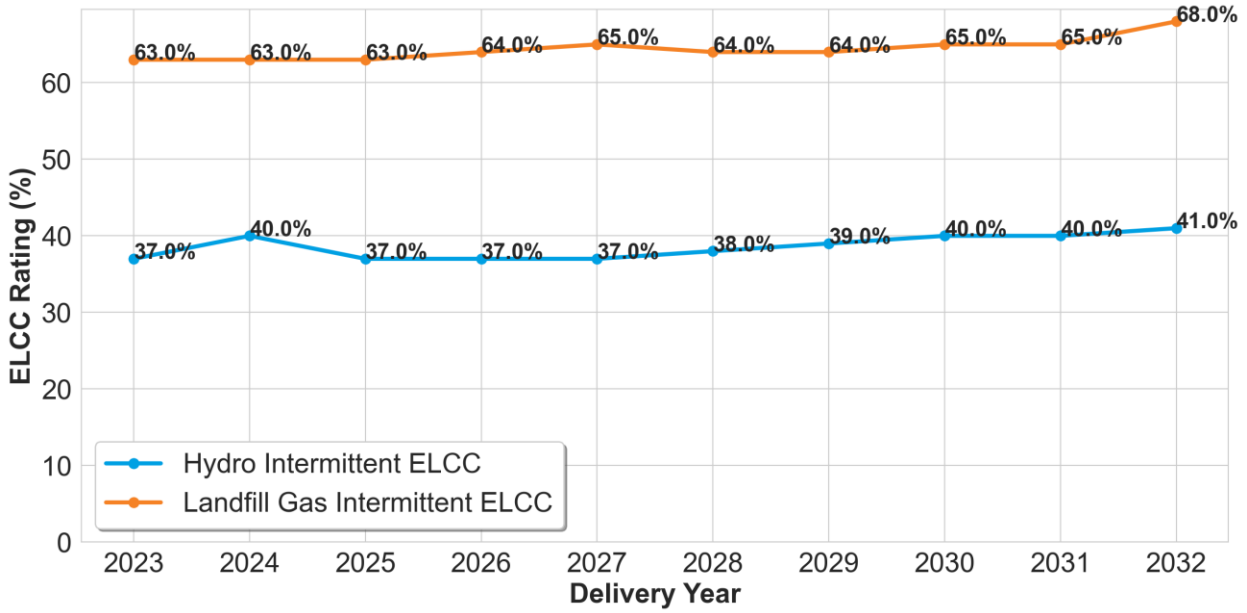
Figure 5: 2023 – 2032 ELCC Class Ratings for 8-hr Storage, 10-hr Storage, Hydro with Non-Pumped Storage



Hydro Intermittent & Landfill Gas Intermittent: 2023 – 2032 ELCC Class Ratings

Figure 6 shows the 2023 – 2032 ELCC Class Ratings for Hydro Intermittent and Landfill Gas Intermittent resources. The ratings for both classes exhibit a slight upward trend.

Figure 6: 2023 – 2032 ELCC Class Ratings for Hydro Intermittent & Landfill Gas Intermittent



Portfolio and All ELCC Classes: 2023 – 2032 ELCC Class Ratings

Table 4 summarizes all the information provided in the above Figures.

Table 4: 2023 - 2032 ELCC Class Ratings and ELCC Portfolio Rating

ELCC Class	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032
Onshore Wind	15%	18%	15%	13%	14%	11%	12%	13%	13%	11%
Offshore Wind	42%	43%	40%	31%	37%	36%	33%	33%	31%	34%
Solar Fixed	50%	45%	37%	33%	27%	24%	21%	16%	12%	10%
Solar Tracking	61%	56%	51%	45%	38%	34%	28%	23%	19%	16%
4-hr Storage	94%	82%	77%	77%	86%	92%	96%	99%	100%	100%
6-hr Storage	100%	98%	96%	94%	94%	98%	100%	100%	100%	100%
8-hr Storage	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
10-hr Storage	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Solar Hybrid Open Loop - Storage Component	93%	85%	74%	83%	89%	99%	94%	100%	100%	100%
Solar Hybrid Closed Loop - Storage Component	93%	85%	74%	83%	89%	99%	94%	100%	100%	100%
Hydro Intermittent	37%	40%	37%	37%	37%	38%	39%	40%	40%	41%
Landfill Gas	63%	63%	63%	64%	65%	64%	64%	65%	65%	68%
Hydro Non-Pumped Storage*	98%	95%	94%	93%	92%	96%	98%	100%	100%	100%
Portfolio	51%	50%	46%	42%	40%	38%	35%	33%	31%	30%

* PJM performs an ELCC analysis for each individual unit in this class. The value shown in the table is a representative value provided for informational purposes

Description of Posted Files

PJM has posted the following files as background information for the calculation of 2023, 2025 and 2026 ELCC Class Rating and Accredited UCAP values (the YYYY characters in the filenames below correspond to either 2023, 2025 or 2026). Note that the data contained in these files is *simulated data* whose only purpose is to calculate ELCC Class Rating and Accredited UCAP values. **The simulated data is not intended to be a prediction of how the system will perform in future years**.

Replications_LOLE_YYYY.zip: this zip file contains a collection of several CSV files, one for each of the scenarios with LOLE in each of the 10 historical weather years (scenarios without LOLE are not posted). The files correspond to the ELCC run that result in the ELCC Class Rating values shown in Table 2 (either 2023, 2025 or 2026). The LOLE of the case is 0.1 days per year. The columns in each file are as follows:

- Unnamed Column: 0-8760(8784). Hour number of the delivery year. The delivery years begin on June 1st.
- Load: In MW. Load at the given hour.
- ThCap: In MW. Unlimited Thermal Capacity available at the given hour (after Forced, Planned and Maintenance outages)
- ThOutageRate: As fraction between 0 and 1. Unlimited Thermal Capacity outage rate at given hour (includes Forced, Planned and Maintenance outages)
- OnshoreWind: In MW. Total onshore wind output at given hour.
- OffshoreWind: In MW. Total offshore wind output at given hour.
- SolarFixed: In MW. Total solar fixed panel output at given hour.
- SolarTracking: In MW. Total solar tracking panel output at given hour.
- HydroInt: In MW. Total hydro intermittent output at given hour.
- LandfillInt: In MW. Total landfill gas intermittent output at given hour.
- 6hrStorage: In MW. Total 6-hr Storage dispatched at given hour.
- HydroNPS: In MW. Total Hydro with Non-Pumped Storage dispatched at given hour.
- OL_Hybrid: In MW. Total Solar Hybrid Open Loop dispatched at given hour (includes solar and storage output)
- CL_Hybrid: In MW. Total Solar Hybrid Closed Loop dispatched at given hour (includes solar and storage output)
- 4hrStorage: In MW. Total 4-hr Storage dispatched at given hour.
- DRDispatched: In MW. Total amount of DR dispatched at given hour.
- Ambient: In MW. Hourly ambient derates during peak weeks of summer. A total of 2,500 MW are modeled as not available to be consistent with Reserve Requirement Study (these derates are not included in ThCap and ThOutageRate columns).

- AddPlannedOutages: In MW. Additional planned outages modeled during winter peak week to be consistent with Reserve Requirement Study (these additional planned outages are not included in ThCap and ThOutageRate columns).
- SolarHyOL: In MW. Total solar component output in Solar Hybrid Open Loop.
- SolarHyCL: In MW. Total solar component output in Solar Hybrid Closed Loop.
- MarginBeforeDR: in MW. Margin before dispatching DR calculated as total available resources minus load.
- MarginAfterDR: in MW. Margin after dispatching DR. This is the margin value used to determine if there is LOLE or not. LOLE is declared if MarginAfterDR is less than -0.1 MW (the model has a tolerance of 0.1 MW).
- LOLE: 0 or 1. If 1, there is loss of load in the given hour; if 0, there is no loss of load.
- Day: 1-365(366). Day number of the year
- Hour Beginning: 0-23. Eastern Prevailing Time Hour beginning.

Load_Scenarios_YYYY.zip: this zip file contains 10 CSV files, one for each of the 10 historical weather years. Each CSV file has either 8,760 or 8,784 rows (one for each hour of the year) and 1,000 columns (one for each of the 1,000 replications; the columns are named from 0 to 999). All values in the files are in MW and represent hourly loads in each scenario.

Available_Unlimited_Thermal_Scenarios_YYYY.zip: this zip file contains 10 CSV files, one for each of the 10 historical weather years. Each CSV file has either 8,760 or 8,784 rows (one for each hour of the year) and 1,000 columns (one for each of the 1,000 replications; the columns are named from 0 to 999). All values in the files are in MW and represent available hourly unlimited thermal capacity available in each scenario. Note that ambient derates and additional planned outages (columns Ambient and AddPlannedOutages in the Replications files) during winter peak weeks are not accounted for in these files.

200_CPX2_YYYY.xlsx: this file contains the hours included in the 200 CPX2 metric used to calculate the Performance Adjustment for Variable Resources and Variable Resources components in Combination Resources. The file has two sheets: the sheet “Gross” has the top 200 gross load hours; the sheet “Net” has the top 200 net load hours where net load is defined as gross load minus the potential output of Variable Resources. Note that the hourly load values in this file should be interpreted as the potential hourly load values (gross and net) in each of the delivery years (2023, 2025, 2026) if the same pattern of historical weather that occurred on the past hours listed in the file were to repeat themselves in those years.