

# 2025 Polar Vortex

RCSTF

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# Winter Events After Elliott

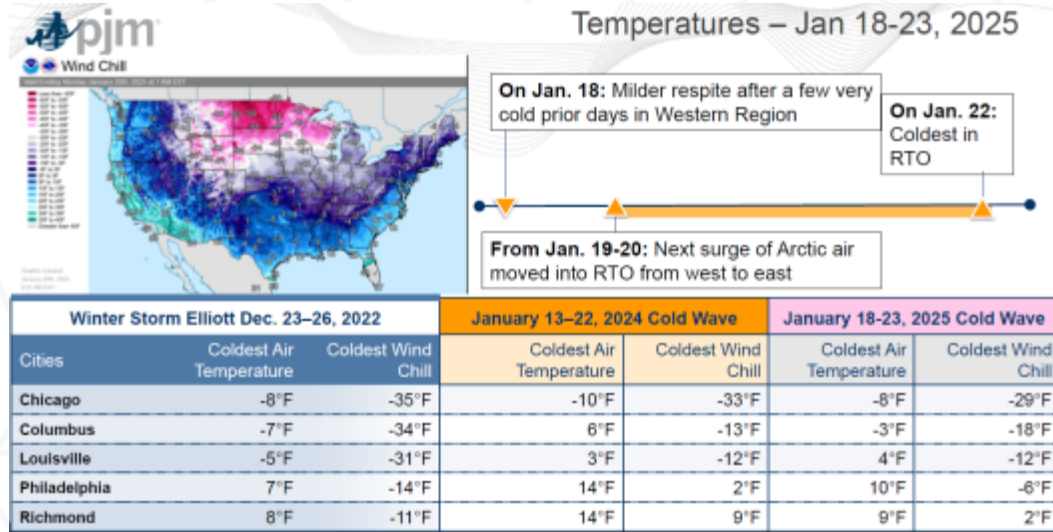
- The decisions made in January 2024 (Winter Storm Gerri) and January 2025 (2025 Polar Vortex) show that PJM does not/will not let generators face their own performance risk.
  - Generators face mechanical risks from not being able to operate or start at cold temperatures.
  - Generators face gas procurement risk from not being able to purchase gas during weekends or intraday.
- PJM reduced these risks by making commitments before markets cleared.
- The current market mechanisms cannot produce these commitments.

# Winter Events After Elliott

- **The goal is not to reflect operational decisions in markets after they have been made.**
  - **If attempted, this will become a lever to set prices.**
- **The goal is to have operational decisions made by markets.**
  - **Prices will be the result of those decisions.**
- **PJM has failed to explain how reforming the current reserve markets would have produced the desired commitments.**
  - **The IMM does not believe that this is possible.**

# Conservative Operations

- The PJM footprint experienced temperatures at or below 10°F between January 20 and 23, 2025.
- In preparation for this event, PJM declared conservative operations from Jan 20 through Jan 23.



Source: "Cold Weather Operations January 18–23, 2025," PJM presentation to the RCSTF. (March 12, 2025).

# Conservative Operations

- **PJM commitment actions:**
  - **Commitment of resources ahead of the cold temperatures.**
  - **Combined cycles and steam turbines were committed on Friday (1/17) for Sun morning through Wed morning to:**
    - Prevent startup failures.
    - Procure natural gas using the weekend package.
  - **Combustion turbines were mostly committed on Friday (1/17) for expected peaks (Mon evening, Tue morning and evening, Wed morning).**
  - **Same actions were taken Tuesday (1/21) morning for gas day 22 (Wed 10:00 to Thu 10:00).**

# Commitment Examples

- **Combined Cycle**
  - **Committed Sun 1/19 10:00 through Wed 1/22 10:00**
- **Combustion Turbine**
  - **Committed Mon 1/20 1600-2200**
  - **Committed Tue 1/21 0400-1000 and 1600-2200**
  - **Committed Wed 1/22 0400-1000**

# Conservative Operations

- **Not all units contacted/committed by PJM on Friday (1/17) for Sunday (1/19) through Tuesday (1/22) and on Tuesday (1/22) for Thursday (1/23) were logged for conservative operations.**
- **Not all units logged for conservative operations operated out of the money (i.e. needed and received uplift).**

Category	19-Jan	20-Jan	21-Jan	22-Jan	23-Jan
Total economic max of units contacted by PJM	46,864	58,109	61,162	59,785	58,674
Total economic max of units logged for conservative operations	34,461	37,814	39,708	41,367	33,340
Total economic max of units logged for conservative operations and paid uplift	23,873	25,499	21,937	24,848	18,007

# Conservative Operations

- **Uneconomic units committed for conservative operations:**
  - **63% CCs**
  - **30% CTs and RICE**
  - **7% oil/gas fired STs**
- **By fuel type:**
  - **96% gas**
  - **4% oil**



# Conservative Operations

- **The early commitments were driven by:**
  - **Operational risk of not being able to start combined cycles and steam turbines due to their minimum operating/starting temperatures.**
  - **Operational risk of not being able to procure natural gas during the weekend and/or intraday.**
- **These risks were eliminated/minimized when PJM scheduled resources before they were needed.**
- **PJM has failed to explain how changing the reserve market would have resulted in these commitments.**

# Cold Weather Operating Limits

- **PJM collected units' cold weather operating limits.**
  - **Operating Temperature Limit:** Lowest ambient temperature at which the plant was designed to operate reliably. Considering all plant systems, components, controls, electrical, mechanical and water systems, including switchyard equipment owned by the Generating Facility
  - **Starting Temperature Limit:** Lowest ambient temperature at which the plant could reliably start.

# Cold Weather Operating Limits 2024 Survey Results

- These results show the most limiting temperature (i.e. the highest temperature between the two parameters).
- This means that **48,770 MW** cannot operate and/or start reliably at temperatures below 0°F.

Lowest Temperature Plant Can Reliable Operate or Start	ICAP (MW)	Accumulated ICAP (MW)
At or above 20F	11,356	11,356
At or above 15F	3,095	14,452
At or above 10F	8,882	23,333
At or above 5F	12,987	36,320
At or above 0F	12,450	48,770
At or above -5F	15,456	64,226
At or above -10F	35,463	99,689
At or above -15F	16,258	115,948
At or above -20F	13,417	129,365
At or above -25F	15,734	145,099
At or above -50F	15,621	160,720

# Gas Pipeline Nominations

- Pipelines can require consumers to nominate gas per the NAESB cycles, based on reliability needs.
- Nominations are for the entire gas day or the balance of the gas day (i.e. ratable takes).
  - NAESB Cycles (Eastern Time):

	Timely	Evening	ID1	ID2	ID3
Nom Deadline	14:00	19:00	11:00	15:30	20:00
Confirmation Deadline	17:30	21:30	13:30	18:00	22:30
Scheduled Volumes Available	18:00	22:00	14:00	18:30	23:00
Start of Gas Flow	10:00	10:00	15:00	19:00	23:00

# Gas Pipeline Nominations

- **Based on the pipelines' nomination constraints, units can be committed during a weekend, units can be committed intraday.**
- **The issues become:**
  - **Commodity supply illiquidity, both during weekends and intraday.**
  - **Bumping of firm transportation service if not nominated prior to ID3.**
  - **Risk of interruption and/or diminishing transportation capacity during intraday nominations.**
- **These issues are eliminated when units nominate gas by the timely cycle and/or purchase weekend packages.**

# Gas Market Risk

Four day weekend package:

Gas traded on Friday morning (Jan 17) for gas to be consumed between Sat Jan 18 10:00 to Wed Jan 22: 10:00.

Effectively a 96 hour minimum run time and up to 118 hour notification time (time required to be notified if needed for Wed morning peak)

Normal next day transaction:

Gas traded on Tue morning (Jan 21) for gas to be consumed between Wed Jan 22 10:00 to Thu Jan 23: 10:00.

Effectively a 24 hour minimum run time and up to 46 hour notification time (time required to be notified if needed for Thu morning peak)

Gas Day	Hours	Operating Day
Gas Day 17	0000-1000	Fri 1/17
	1000-2400	Operating Day
Gas Day 18	0000-1000	Sat 1/18
	1000-2400	Operating Day
Gas Day 19	0000-1000	Sun 1/19
	1000-2400	Operating Day
Gas Day 20	0000-1000	Mon 1/20
	1000-2400	Operating Day
Gas Day 21	0000-1000	Tue 1/21
	1000-2400	Operating Day
Gas Day 22	0000-1000	Wed 1/22
	1000-2400	Operating Day
Gas Day 23	0000-1000	Thu 1/23
	1000-2400	Operating Day

# Gas Market Risk

If an expensive gas fired unit was only needed to meet the Wed 1/22 morning peak (08:00), that unit had to be committed on Friday morning (10:00) to operate from Saturday 10:00 to Wednesday 10:00.

If not committed on Friday morning, the units' expected availability for Wed 1/22 morning decreases because of the uncertainty of procuring gas on Tuesday morning.

Gas Day	Hours	Operating Day
	0000-1000	Fri 1/17
	1000-2400	Operating Day
Gas Day 17	0000-1000	Sat 1/18
	1000-2400	Operating Day
Gas Day 18	0000-1000	Sun 1/19
	1000-2400	Operating Day
Gas Day 19	0000-1000	Mon 1/20
	1000-2400	Operating Day
Gas Day 20	0000-1000	Tue 1/21
	1000-2400	Operating Day
Gas Day 21	0000-1000	Wed 1/22
	1000-2400	Operating Day
Gas Day 22	0000-1000	Thu 1/23
	1000-2400	Operating Day
Gas Day 23	0000-1000	
	1000-2400	

## Gas Market Risk (NEW)

- **Although gas procurement risk was reduced by the early commitments, some units:**
  - **Procured natural gas for the entire four day weekend package, even though the commitment was only for three days.**
  - **Procured natural gas for operating at eco max, even though they ended up operating closer to eco min.**
- **This resulted in losses from gas disposed at a loss or uneconomic operation (e.g. Saturday gas day).**
- **Based on an IMM data request to gas fired generations, the losses from gas sales were above \$30 million.**



# Risk Based Scheduling Approach

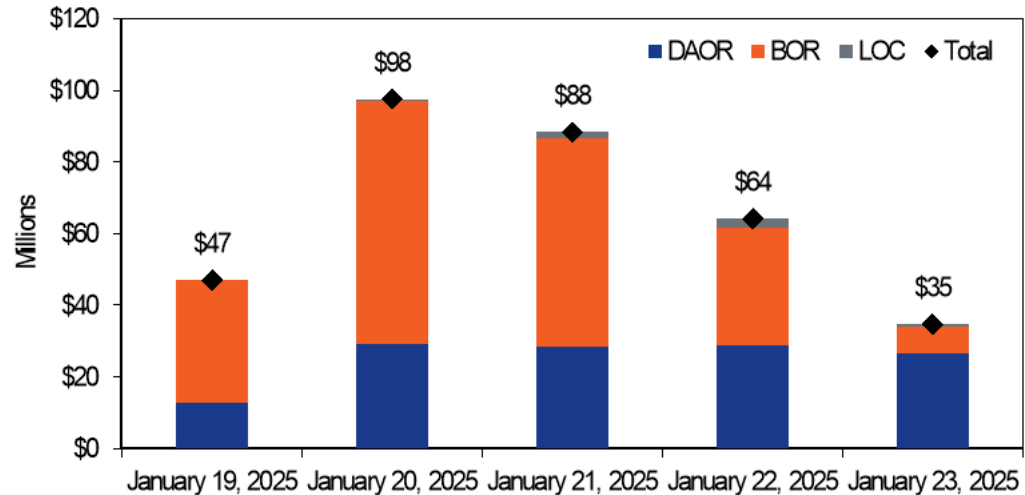
- **PJM took out of market actions to reduce the performance risk of generators. The risks were:**
  - **Not being able to start/operate at cold temperatures**
  - **Not being able to procure natural gas after Friday for Sunday, Monday, Tuesday and Wednesday (morning).**
  - **Not being able to procure natural gas after the morning of Tuesday for Wednesday (evening) and Thursday (morning).**

# Results of Conservative Operations

- **Good generation performance.**
- **Enough supply to meet all time winter peak plus 7,700 MW of exports.**
- **DR not called (8,065 MW)**
- **No PAIs.**
- **No shortage pricing.**
- **\$332 million in uplift payments.**
- **At least \$30 million in gas procurement gross losses.**
  - **Source: IMM Data Request.**

# Uplift

- Jan 19 through Jan 23: \$332M (day ahead, balancing operating reserve credits and LOC).
  - Day ahead: \$126M (38%)
  - Balancing: \$200M (60%)
  - LOC: \$6M (2%)



## Uplift (Balancing)

- **Balancing operating reserve (BOR) credits is mainly paid to units that operate in real time without a DA schedule.**
- **BOR costs allocation depends on the commitment timing (during the reliability analysis or during the operating day).**

## **Uplift (Balancing)**

- **For units committed during the reliability analysis:**
  - **BOR is allocated to deviations when the commitment was to increase the physical resources committed DA to meet forecasted load plus reserves. (Deviations)**
  - **BOR is allocated to real-time load and exports when the commitment was to maintain system reliability. (Reliability)**
- **For units committed during the operating day, the allocation between deviations and reliability depends on how many intervals the unit is out of the money.**
- **Reference: OA Schedule 1 Section 3.2.3 (b) (i) and (ii)**

## **Uplift (Balancing)**

- **BOR between Jan 19 and Jan 23 was \$200M.**
  - **Only \$0.2M was paid to units scheduled during the operating day. The rest was paid to units scheduled during the reliability analysis for conservative operations.**
  - **\$198M (98%) was allocated to real-time load and exports. This allocation is made when the units are committed to maintain reliability.**
  - **\$2M (2%) was allocated to deviations. This allocation is made when the units are committed to meet load forecast plus reserves.**
- **The majority of the BOR was paid to maintain reliability, not to increase the physical resources committed DA to meet forecasted load plus reserves.**

# Uplift

- **DA uplift was the result of units committed for transmission reliability in the Day-Ahead Market. This uplift was not the result of conservative operations.**
- **DA uplift was not the result of committing units for reserves.**
- **BOR uplift was the result of multiday commitments to address generation performance risk. These units were committed ahead of time but did not clear the Day-Ahead Market.**
- **Distinct reasons for DA uplift versus BOR uplift.**
  - **DA: Transmission related.**
  - **BOR: Generation performance risk related.**

# Summary

- **PJM had to make early unit commitments due to the risk of not being able to start CCs and STs during the expected low temperatures.**
- **These commitments cannot be made by the energy markets (DA/RT) since PJM does not have a market that procures energy multiple days in advance.**
- **Some of these commitments were uneconomic and received uplift.**
  - **Some for the entire period.**
  - **Some only for days with lower LMPs (Sun 1/19 and Mon 1/20).**



# The problem

- **The PJM energy market cannot produce multiday commitments or commitments before DA.**
- **The PJM energy market was not set up to perform multiday commitments or commitments before DA.**
- **The PJM energy market is a daily market which procures energy and reserves on a day-ahead basis and in real time.**
- **The root of the problem is not the current Day-Ahead or Real-Time Energy/Reserve Markets.**
- **This is not a reserve certainty problem.**

# The problem

- **Capacity resources today continue to have no clear requirements when compared to the capacity resources that existed prior to CP.**
- **CP was created to address two issues from the 2014 Polar Vortex.**
  - **High outages during Jan 6-8, 2014 caused by equipment failures due to cold temperatures and gas interruptions.**
    - Same as Winter Storm Elliott.
  - **High uplift payments during Jan 17-29, 2024 caused by natural gas market constraints (long notification times, weekend packages).**
    - Same as January 2025
- **CP has failed to address/resolve these issues.**

# Capacity Definition

- **CP was introduced after the 2014 Polar Vortex.**
  - **2014 Polar Vortex events: Near miss in early Jan, conservative operations/high uplift in late Jan.**
- **As defined by PJM:**
  - **A Capacity Performance Resource provides greater assurance of delivery of energy and reserves during emergency conditions. (PJM CP Filing 205 P2).**
  - **A Capacity Performance Resource must be capable of sustained, predictable operation that allows the resource to be available to provide energy and reserves whenever PJM determines an emergency condition exists. (PJM CP Filing 205 P22).**

## CP Description – PJM Filing

- **“Rather than establishing prescriptive eligibility requirements such as delineating acceptable fuel transportation arrangements, storage requirements for dual fuel capable units, or weatherization requirements, PJM proposes that an offer as a Capacity Performance Resource includes a representation that the Capacity Market Seller has made, or will make, the necessary investment to ensure the resource has the capability to provide energy when called upon by PJM.” (PJM CP Filing 205 P22).**

## CP Description – PJM Filing

- **A Capacity Performance Resource must represent that it:**
  - **“Has made, or can and will make, the necessary investment to ensure the Capacity Resource has the capability for the entire relevant Delivery Year to provide energy at any time when called upon by the Office of the Interconnection;**
  - **Shall be capable of complying with the performance obligations specified in this Attachment DD of the Tariff and Schedule 1 of the Operating Agreement by the relevant Delivery Year [Operating Parameter Limits];”**
  - **(PJM CP Filing 205 P23)**

## CP Description – PJM Filing

- **These provisions were rejected by FERC and removed.**
- **FERC argued that it was “concerned that significant aspects of the required representation are inappropriately vague and this ambiguity could incent well-performing resources to elect not to participate in the capacity market to avoid the risk of sanction”. (151 FERC ¶ 61,208 P95)**
- **In terms of requirements, without this provisions, CP reverted to the legacy capacity definition. Without this provision, any resource can and did become CP.**

# Operating Parameters – PJM Filing

- **CP proposed operating parameter limits based on physical operating design.**
- **The main goal was to limit the uplift payments experienced in late Jan 2014 due to gas market inflexibility (CP PJM Filing 206 P7).**
- **Operating parameters would be unit specific based on the resources' physical capabilities.**
- **Also, during Hot or Cold Weather Alerts, the sum of the notification and start times could not exceed 14 hours and the notification time could not exceed 1 hour.**

# Operating Parameters – PJM Filing

- These provisions were rejected by FERC and changed.
- FERC argued that “because PJM’s proposed revisions are based only on physical constraints and generic time restrictions that may prevent a resource from reflecting in its energy market offer certain parameter limitations caused by legitimate, non-physical constraints”. (151 FERC ¶ 61,208 P435)
- These provisions were modified to allow operating parameter limits based on contractual limits that cannot be rectified with other commercial alternatives.



## End Result

- **A Capacity Performance resource was supposed to be a superior product compared to the Capacity Resource that existed in 2014.**
  - **It was supposed to produce and maintain investments to perform better.**
  - **It was supposed to seek better fuel contractual arrangements.**
- **This has failed by having no clear requirements on what it means to be CP.**
- **Instead, any resource can be CP by facing the financial consequences of bad performance, but only during a PAI.**

# End Result

- **Today, a Capacity Performance resource can be:**
  - **A resource that only has interruptible gas**
  - **A resource that only provides energy when the sun is out**
  - **A resource, not base load, that takes 48 hours to start**
  - **A resource with a 96 hour minimum run time**
  - **A resource that cannot start when temperatures are below 10°F.**
- **When CP was envisioned, these would not qualify as providing “greater assurance of delivery of energy and reserves.”**

## End Result

- From a market perspective, PJM expects resource owners to bear all the performance risks and reflect their nonperformance financial risks in their capacity offers (i.e. CPQR).
- From an operational perspective, PJM is not willing to let resources face such risks. Instead PJM scheduled units at risk in advance instead of waiting for the DA market.
- PJM market design treats any resource as a capacity resource as long as it bears the risks from nonperformance but PJM actual operations prevents resources from bearing such risks.

## Next Steps

- **Accept the reality that PJM will have to make advance, out of market, decisions during critical days to reduce generation performance risks.**

**or**

- **Require capacity resources to be able to start within the DA market timeframe or to be online when alerts are in place.**

## Next Steps

- **Accept reality: Units that cannot start/operate within the Day-Ahead Energy Market timeframe (about 16 hour time to start, 13:30 of the day before to 05:00 of the next day) have to be committed before the DA Market.**

**or**

- **Define capacity resources: Require capacity resources to be able to start within 16 hours or be online when alerts are in place.**

# Accept Reality

- **PJM will need a defined and transparent process for the commitment of units before the DA Market.**
- **The process must include:**
  - **Criteria defining when this is invoked**
  - **Energy offers development rules**
  - **Tools used to optimally schedule resources**
  - **Communications process for these commitments**
  - **Operating parameters review (temperature limits)**
  - **DA Market participation**
  - **Uplift changes to account for multiday net profits/losses.**
  - **Treatment of limited resources, dual fuel, demand response.**

# Define Capacity Resources

- **Create minimum operational requirements for capacity resources to ensure that these resources can be committed by the DA Market.**
- **Units that cannot start based on the DA Market timeframe will be required to be online based on alerts invoked by PJM.**

# Resource Adequacy

- **Either way, PJM must reflect expected performance based on actions taken through conservative operations. Historical construct of ELCC fails to account for change in behavior from generators and from PJM operations.**
- **Either way, resources must have explicit operational requirements.**
- **These are significant changes but necessary to avoid overestimating risk now which will result in overprocurement in the future.**



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