

Financial Systems for Supporting a Market -Based Renewable Ecosystem



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How Markets Support Green Solutions

- Sub-hourly Markets mitigate uninstructed energy risk
- New Ancillary service products provide opportunity for storage and demand
- Flexible Reserve Markets for Enhanced System Stability
- Operational capacity products, price-sensitive load, peak shaving, flexible demand
- More accurate, more transparent price signals for new infrastructure – transmission, green energy, flexible generation



Can Your Settlement System Keep Pace with Dynamic Markets?

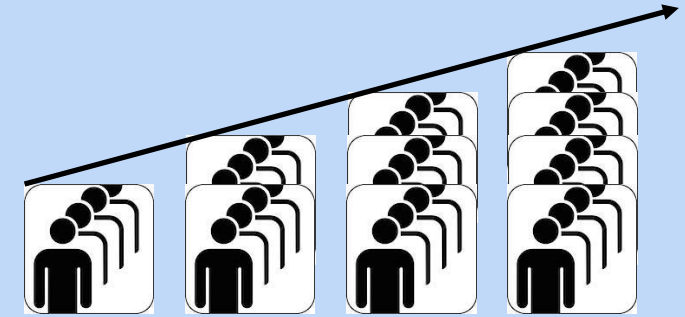
- More Market Intervals, More Products, More Complexity = More Demands on Settlements!
- More Data
- More Complex Calculations
- Extensive Data Acquisition Needs
- More Demands on Staff
- More Demands on IT Systems
- Spreadsheets, Manual Processes and In-House Widgets Won't Get it Done.



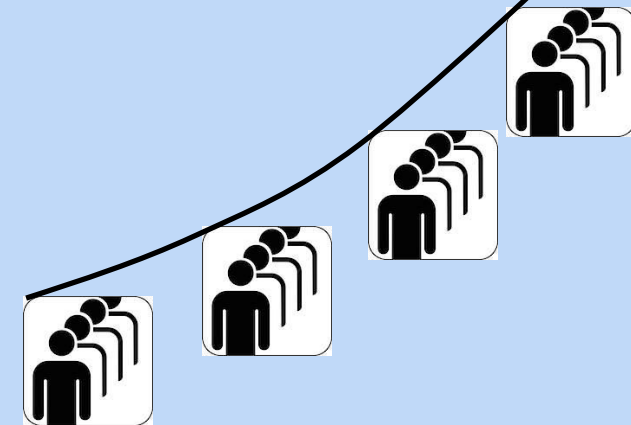
Don't Get Behind the Growth Curve

- Early Implementation allows new system to easily adapt to market changes.
- Automated processes empower staff to handle more business with less effort.
 - More responsive to change
 - More responsive to opportunity
- Early adoption means:
 - Easier, lower-cost transition of staff and systems
 - Earlier access to cost savings
 - Earlier support for growth without staffing constraints

Linear Capability Growth
Constrained by Staffing



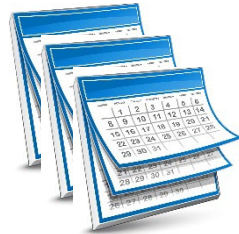
Exponential Capability Growth By
Enhanced Efficiency



Automate to Manage a Fast -Paced Market

Configuration

Task Calendars
Hourly
Daily
Business Cycle
Special



Task Schedules
Data Acquisition
Pre-Processing
Calculation Cycles
Housekeeping

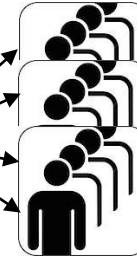


Task Dependencies
Precursor Tasks
Task Hierarchies
Status Checking
Launch when Ready



Execution

Queuing and Threading
Multithreaded Execution
Optimized Resource
Utilization
Prevent Deadlocks
Log Status and Results



Logging
File, Database and
Console Logs
Configurable Logging
Detail
All Tasks Tracked



Check and Retry

Success?

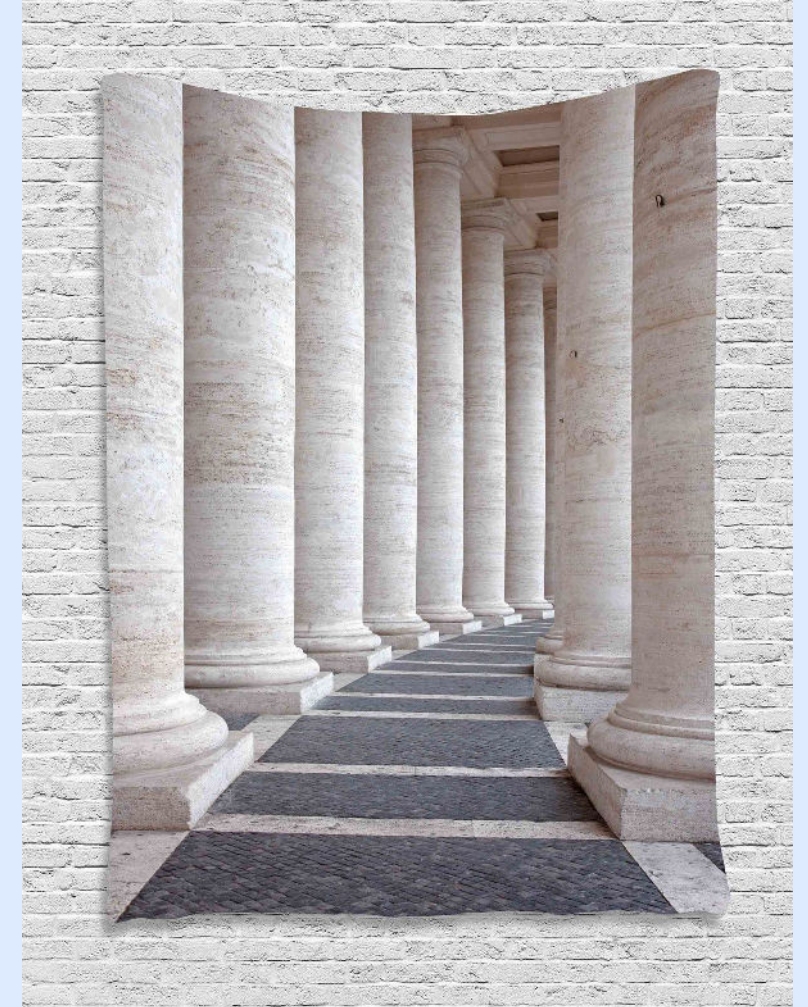
Retry

Complete!

Notify

The Five Pillars of Long -Term Value

- I Flexibility: Support Market Rule Changes with backward compatibility and the ability to maintain full versioning of data and calculations.
- I Scalability: Plan for increasing data volume and market complexity.
- I Maintainability: Ability for staff to update and maintain configuration and calculation sets.
- I Availability: Maintain on-line access to current and historical data, on a high-reliability hardware platform
- I Auditability: Full tracking of “who, what, when, why” for all data



About EnDimensions LLC

- EnDimensions LLC is Based in Silicon Valley, Providing Energy Settlements and Market Operation Platforms for Energy Market Operators and Utilities Worldwide.
- Our EnSuite[®] Financials Package Leads the Industry in Performance, Scalability and Reliability.
- EnDimensions LLC provides Implementation Services Including Market Design, Data Modeling, Integration, and Business Process Design in Support of Settlements and Market Operations.
- Our Clients Include Large Investor-Owned Utilities (IOUs), ISO/RTO Operators, Generation Owners and Transmission Owners
- Our Focus is to Provide Visionary Expertise and Advanced Software Tools that Enable the Transformation of Energy Markets and Market Operations Across the Globe.



Thank You!

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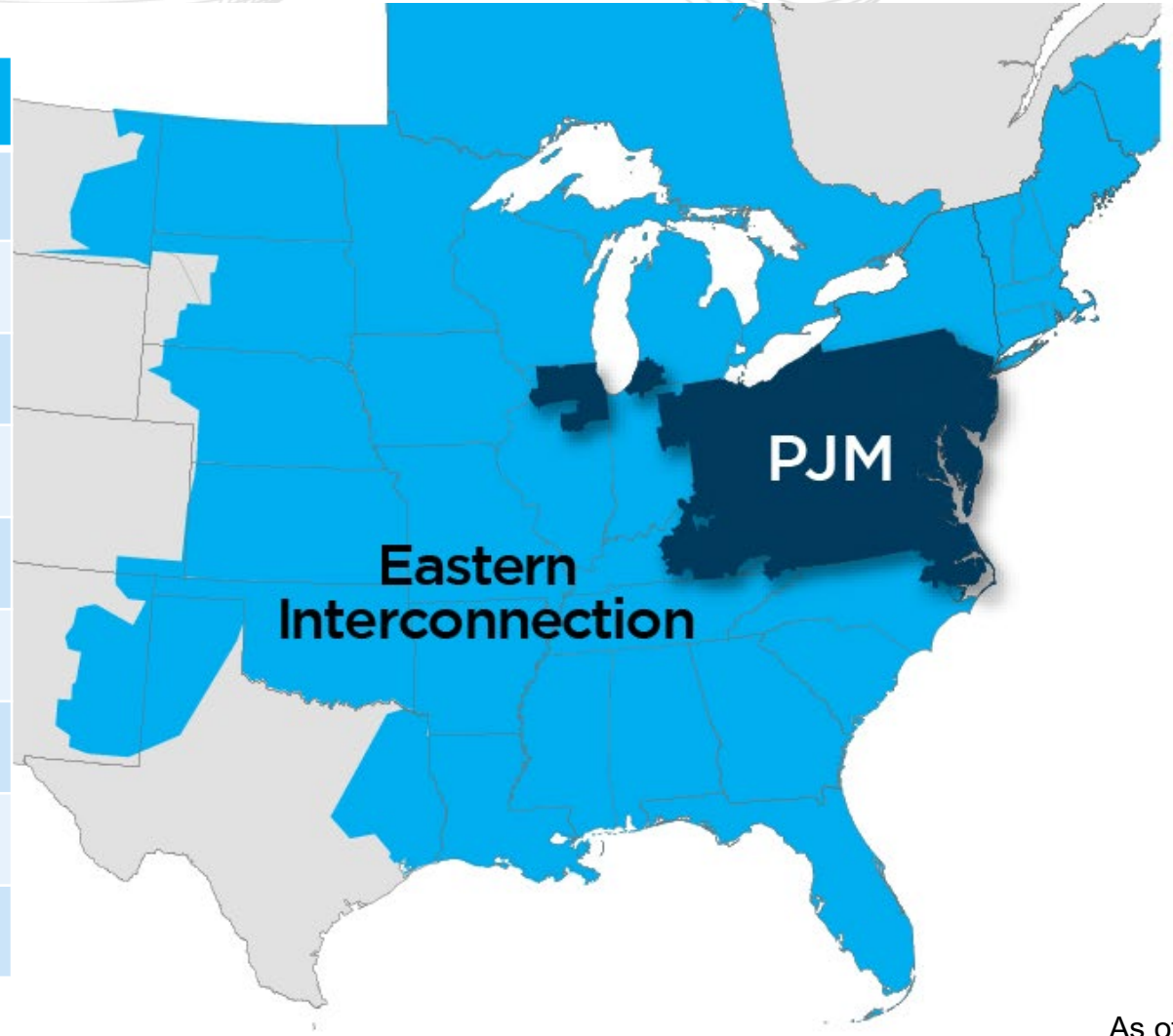
Importance of Flexibility in a Changing Resource Environment

APEX September 2023

Tim Horgler
PJM Interconnection L.L.C.
Senior Director, Forward Market Operations &
Performance Compliance

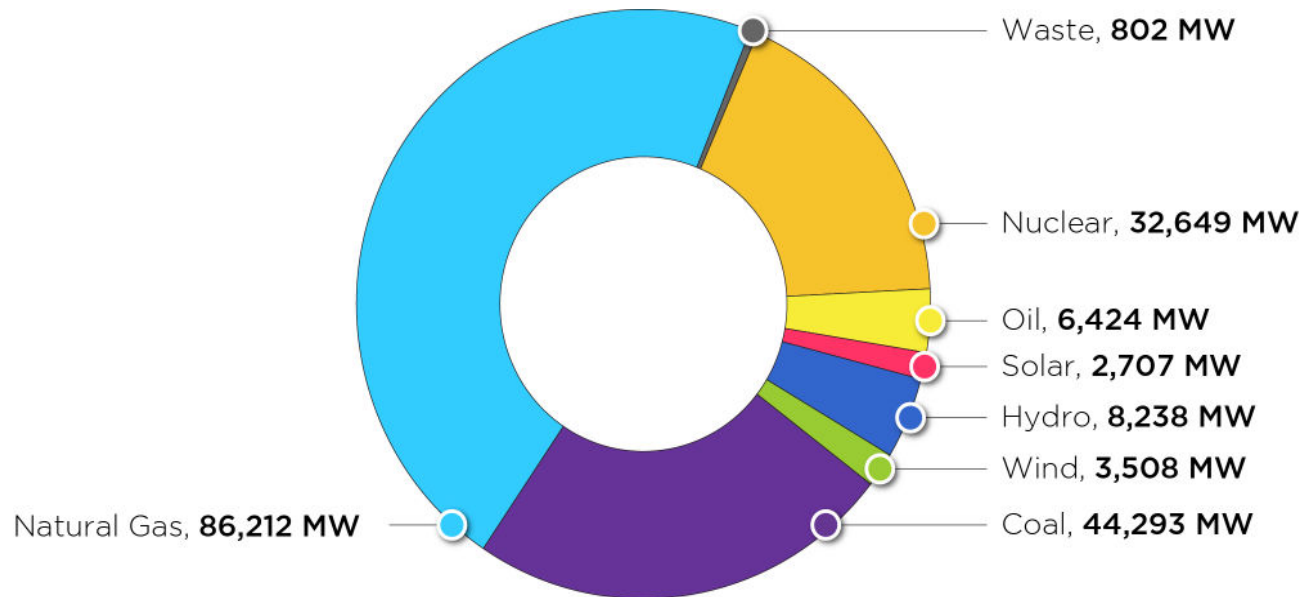
Key Statistics

Member companies	1,110+
Millions of people served	65+
Peak load in megawatts	165,563
Megawatts of generating capacity	183,254
Miles of transmission lines	88,115
Gigawatt hours of annual energy	795
Generation sources	1,419
Square miles of territory	368,906
States served	13 + DC



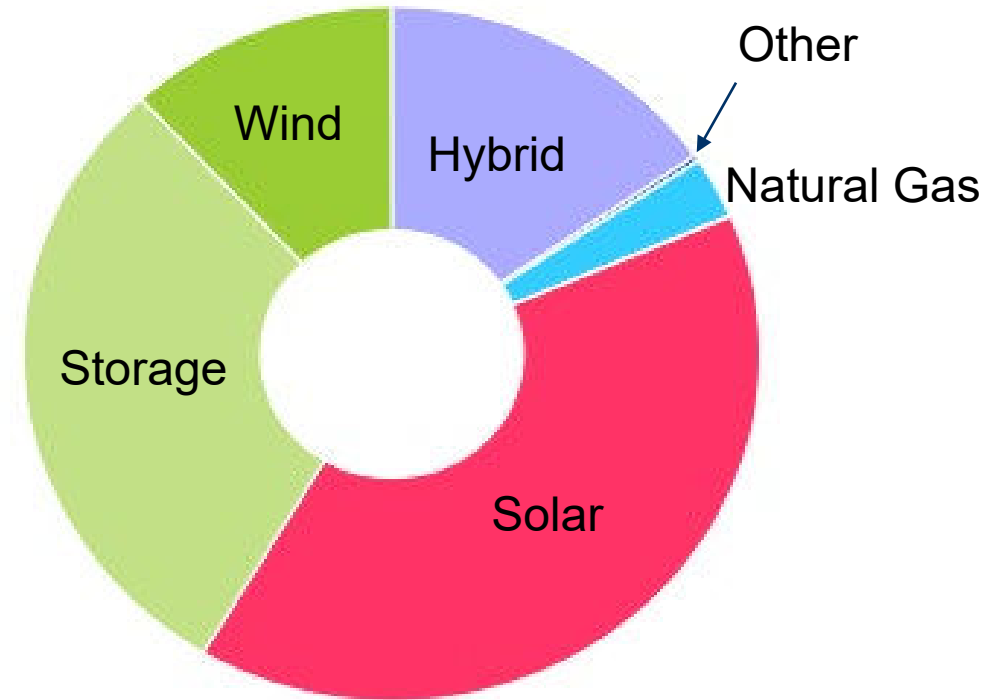
As of 2/2023

PJM Existing Installed Capacity Mix



Total: 184,833 MW

Current Interconnection Queue

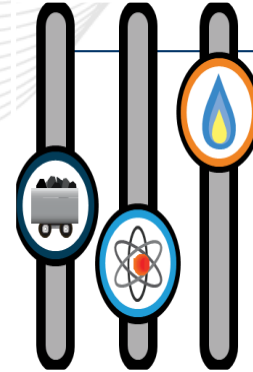


Total: 186,136 MW

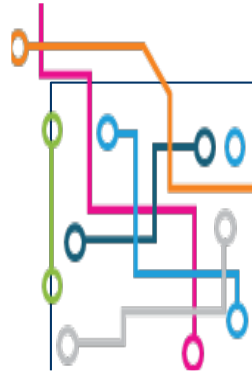
Key Point: Significant shift to cleaner resources is expected in PJM Region.



Intermittent and limited-duration resources not equivalent to thermal generation. (reduction in flexibility)



Thermal generators are retiring at a rapid pace due to government and private sector policies as well as economics.



The growth rate of electricity demand is significantly increasing due to electrification and high-demand data. Load Forecasting becomes more challenging



Challenge with maintaining and attracting essential Reliability Services, including voltage control, frequency support and ramping capability.

Key Focus areas

- Accurately account for the capacity contribution of generators
- Ensure flexibility needs of the system through price formation initiatives
 - Incentives for thermal generators
 - Market requirements need to be consistent with Operator actions so the correct incentives are included in the Market and not priced out-of-the-market
- Strategic regional transmission expansion and grid-enhancing technologies
- Evolvement of reliability standards
- Products needed to address uncertainty with the load forecast and future ramping needs

Energy Transition in PJM: Special Report
Location: [PJM.com – Library – Reports and Notices – Special Reports](https://www.pjm.com/libraries/reports-and-notice/special-reports)



Resource flexibility requirements

Up and Down Regulation signals

Derate renewables with higher deployment

Enhance forecasting

Intraday unit commitment: more frequent updates, more granular

New Technologies

Demand Response

Sloped Reserve Demand Curves



MR MARKET REFORM

Panel 2: Facilitating the Energy Transition Markets – What Can They Do and What Can't They? APEX Conference, Istanbul

Todd Bessemer
21 September 2023

Market Challenges – in the operational timeframe



Classic generator was considered to provide a market commodity:

- Electrical energy – sold both ‘spot’/real-time and in ‘ahead’ timeframes

... and various market-procured and non-market system/ancillary services, e.g.:

- Reserves – synchronous and non-synchronous
- Frequency regulation – of various flavours
- Reactive power
- Black-start capability

Other assumptions:

- Demand was mostly passive, but predictable
- Distribution-level activity could be homogenized and represented as load
- Locational challenges ‘simplified’ from the market, as an issue for the TSO to address

But some characteristics were implicit:

- Dispatchability/output control
- Inertia (rate-of-change of frequency)
- Voltage waveform (system strength)
- Flexibility (e.g. fast ramping)

With the evolving resource mix

- Fewer resources can provide these characteristics
- Market constructs must evolve to properly compensate those that do/can
- Demand will need to shoulder more of the balancing and system services burden
- DER becomes more important, driving need for better (a) observability; (b) controllability and (c) market integration
- The ‘where’ and not just the ‘what’ must be better addressed by the market

Market Challenges – in the investment timeframe

Renewables mostly in new locations

- Need to go to where resource potential is highest.
- Few projects can effectively use ‘brownfield’ sites

Driving (non-market) transmission costs

- Need for extensive transmission build-out, to connect and ensure system stability.
- Often driven by central planning rather than market forces.

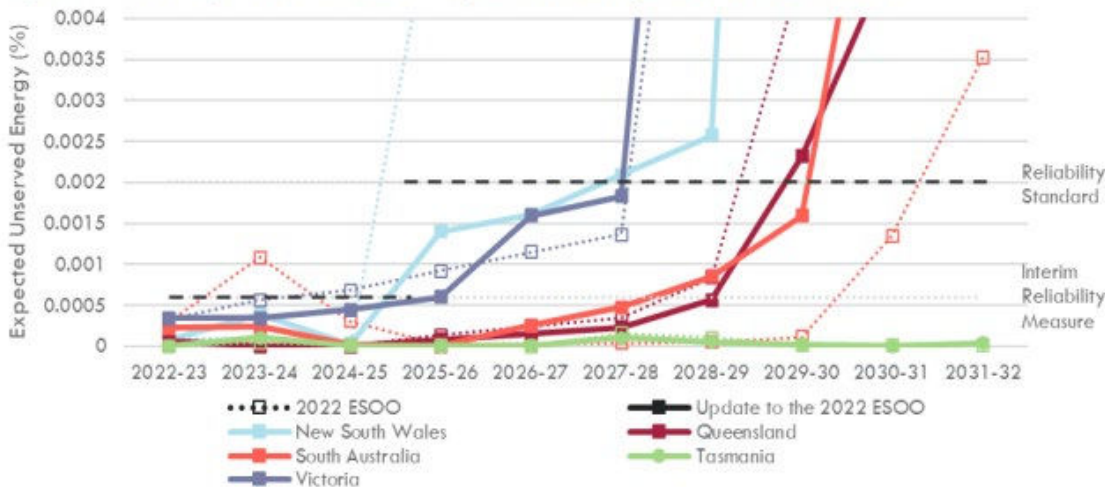
Most renewables still require subsidies to be ‘investable’

- In the form of portfolio standards/RECs, emissions permits, tax credits, etc.
- Externalities suppress energy and, where applicable, capacity prices.
- This is the policy intent – making renewables more attractive vs. other resources.

Creating a disorderly transition when not well planned

- Traditional resources, with diminished revenue, cut back maintenance; plan for early closure – often inducing scarcity.
 - In multi-jurisdiction markets (e.g. Australia, PJM), incentives in one jurisdiction impact pricing in others, with different incentives.
- ⇒ Further subsidies for favoured resources, taking more activity out of the market.

Figure 1 Reliability and indicative reliability forecasts, all regions, 2022-23 to 2031-32



Source: AEMO, *Update to 2022 Electricity Statement of Opportunities*, February 2023

Futures markets have long had the concept of product maintenance – active review of and modifications to product specifications as the market evolves.

Market design principles say:

- “A market should be as simple as possible – but no simpler” - Ruff
- Keep as much activity in the primary energy market as possible
- Markets should incent the attributes desired, not specific technologies



How is this playing out in actual markets?

- Range of new system services products
 - Inertia
 - Fast frequency response
 - Firming to correct for forecast errors
- Changes to energy market to incent dynamic and other characteristics
 - 5-minute settlement
 - Nodal pricing
- Flexibility markets
- Further capacity market redesign

Issues

- # of providers for certain products
 - ⇒ Liquidity
 - ⇒ Market power
- Single buyer (TSO) vs. plurality of demand
- Complexity and participant sophistication
- How do flexibility markets:
 - Integrate with regular energy market?
 - Reconcile conflicting TSO & DSO needs?
- Wide variety in flexibility market requirements.
- But what is ‘capacity’ now? Who’s eligible?

An Interesting (Potential) Implication

- Consider, disparate regions, connected by data lines, but not electrically
- Less controllable generation \Rightarrow flexible demand will increasingly be the marginal price setter.
- Data centre load is particularly displaceable across geographic regions.
- Energy costs \gg data costs.
- The price in one region can therefore guide whether to displace processing load to another.
- This creates an explicit cross-market price linkage between power systems

