

# **Fundamentals of Transmission Operations**

## **Introduction**

**PJM State & Member Training Dept.**

Upon completion of this module, the student will be able to:

- Describe the structure of the Fundamentals of Transmission Operations (FOTO) course
- Define PJM's role as a Regional Transmission Organization (RTO)
- Describe the relationship between PJM and its Member Companies
- Identify the PJM Training and Certification requirements for Transmission Owner operators

- Introduction to FOTO
- Introduction to PJM
- Member TO Training and Certification Requirements

# Course Outline

- Schedule
  - 0800 Daily Start Time
    - Open Discussion Format – Please use microphones provided on table so everyone can hear your questions and comments
  - Lunch & Breaks
    - Schedule
    - Locations
  - End of Class Day
    - Shuttle schedule
    - Turn in badges daily



# Course Outline

- Housekeeping
  - Evacuation procedure
  - Restrooms
  - Break/smoking locations
- Productivity
  - Phones on vibrate
  - Wireless printer available
    - Email document to [pjmctc1@hpeprint.com](mailto:pjmctc1@hpeprint.com)
  - Quiet area (near wireless printer)



# The FOTO Course

- This goal of this course is to provide you with the knowledge you need to successfully execute any of the shared tasks on the Transmission Owner Operator Task List
- This task list is mandated by NERC (PER-005) and also serves as the basis for the PJM Certification Exam
- Task List is continuously evaluated by the PJM Dispatcher Training Subcommittee (DTS)

- Introduction to FOTO
- **Introduction to PJM**
- Member TO Training and Certification Requirements

# **What is an RTO?**



# PJM as an RTO

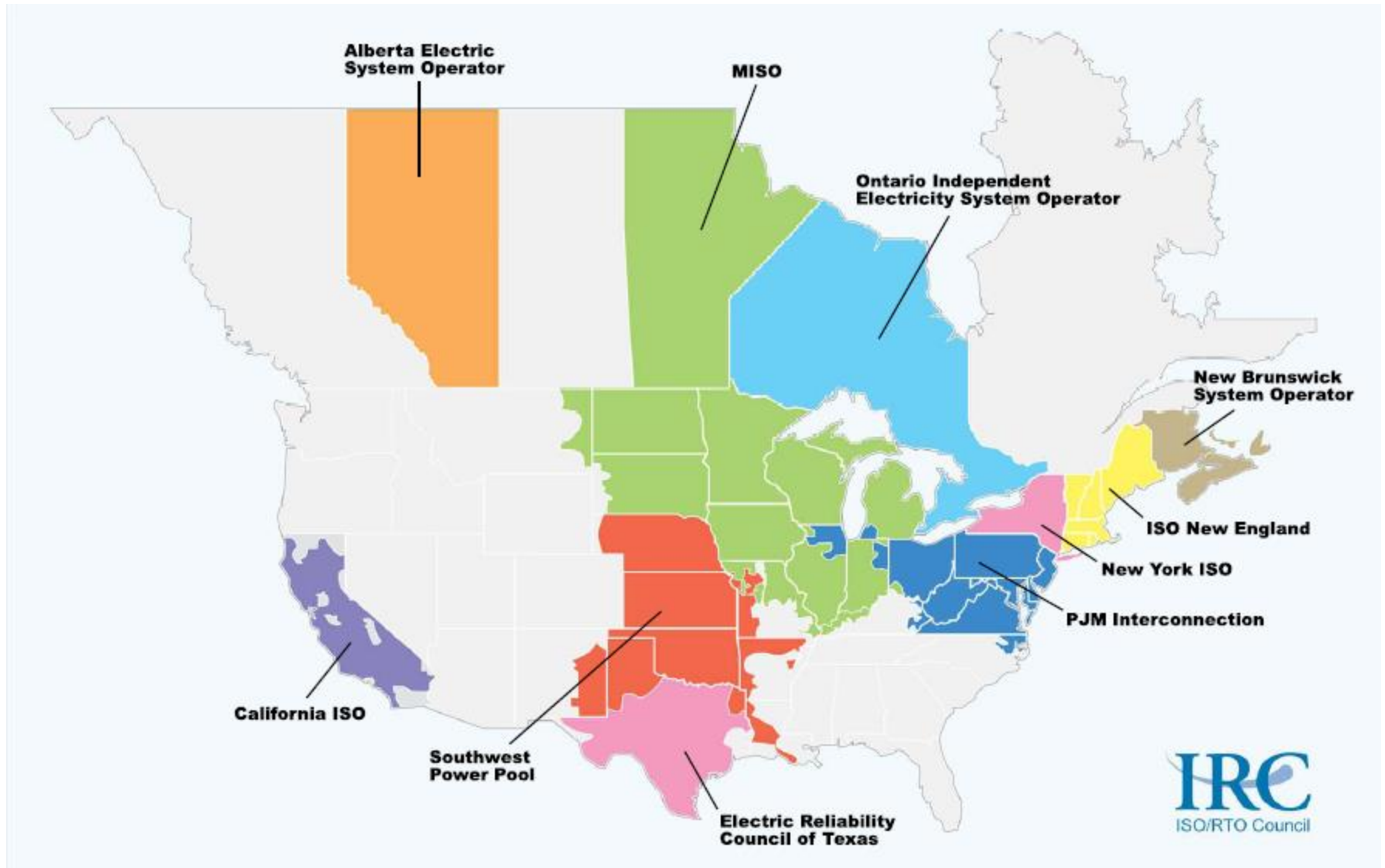
- **What is an ISO/RTO?**
  - Independent from all market participants
  - Independent governance structure
  - Possesses operational authority
  - Responsible for (within the region):
    - Grid operations
    - Reliability
    - Transmission service

# PJM as an RTO

- **Functions**

- Administer tariff
- Administer regional wholesale electric markets
- Provide independent market
- Provide for comprehensive regional transmission expansion planning
- Manage congestions
- Supply ancillary services
- Operator OASIS
- Plan and coordinate transmission additions and upgrades

# Nine Major North American RTOs/ISOs



# **PJM and Committee Structure**

# PJM Governance Structure

## *Two Tier Governance Structure*

### **INDEPENDENT BOARD**

- Ensures safe and reliable grid operation
- Ensures competitiveness of markets
- Ensures no undue influence over PJM Operations
- No affiliation or financial stake in PJM Markets

### **MEMBERS COMMITTEE**

- Elect the PJM Board Members
- Provide recommendations and advice to the PJM Board
- Amend Operating Agreement subject to FERC approval



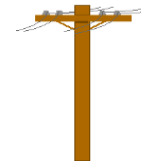
**Generation  
Owners**



**Transmission  
Owners**



**Other  
Suppliers**



**Electric  
Distributors**



**End-Use  
Customers**

# Working Together

- Agreements are developed with stakeholders to ensure reliability of the electric power grid
- Stakeholders include:
  - Members
  - ISOs/RTOs
  - FERC
  - NERC
- ***PJM Operating Agreement***
  - Governs operation of PJM
  - Defines roles & responsibilities
  - PJM Membership requires signing of PJM Operating Agreement



# Purpose And Use of the PJM/TO Matrix

- PJM has the responsibility for planning and directing the operation of PJM Transmission Facilities in accordance with applicable NERC, RFC, SERC and PJM standards
- Requirements for Transmission Owners to assure compliance by both the TO and PJM in the role as the TOP, RC and BA
  - Various agreements
  - PJM Manuals
  - PJM TO/TOP Matrix
    - <http://www.pjm.com/~media/markets-ops/compliance/pjm-to-top-matrix-version-6.ashx>

# Purpose And Use of the PJM/TO Matrix

- Those requirements cover all of the following areas:

Security	Training	Staff Certification	Responsibility and Authority	Transmission Operations
Emergency Operations	Operations Planning	Real-time Monitoring (Meters	Plans for Loss of the Primary Control Center	System Restoration
Outage Coordination	Capacity and Energy Emergency Plan	Nuclear Power Interaction	Communications Facilities	Operator Voice Communications
Ratings Coordination	Modeling	Voltage Control	Protection Coordination	Sabotage Reporting



# NERC Functional Model



# NERC Functional Model – Transmission Operator

- Definition
  - The functional entity that ensures the Real-time operating reliability of the transmission assets within a Transmission Operator Area
- Tasks
  - Monitor and provide telemetry (as needed) of all reliability-related parameters within the reliability area
  - Monitor the status of, and deploy, facilities classed as transmission assets, which may include the transmission lines connecting a generating plant to the transmission system, associated protective relaying systems and Special Protection Systems
  - Develop system limitations such as System Operating Limits and Total Transfer Capabilities, and operate within those limits
  - Develop and implement emergency procedures
  - Develop and implement system restoration plans
  - Operate within established Interconnection Reliability Operating Limits
  - Perform reliability analysis (actual and contingency) for the Transmission Operator Area
  - Adjust flow control devices within the transmission area to maintain reliability
  - Deploy reactive resources to maintain transmission voltage within defined limits

# NERC Functional Model – Transmission Owner

- Definition
  - Owns and provides for the maintenance of transmission facilities
- Tasks
  - Develop interconnection agreements
  - Establish ratings of transmission facilities
  - Authorize maintenance of transmission facilities rights-of-way
  - Design and install owned facilities classified as transmission and obtain associated rights-of-way
  - Design and authorize maintenance of transmission protective relaying systems and Special Protection Systems

# FERC/NERC/RFC/SERC Expectations

- PJM, as the TOP, is involved in all transmission operating decisions
  - Pre-existing procedures can be executed by the TO, but PJM approves any deviations
  - New procedures do not proceed without approval from PJM as the TOP
- All TOP requirements are performed by PJM
  - Tasks can be assigned to the TOs, but only via an agreement and with *PJM still holding the responsibility*
- PJM has enough knowledge and information, so that it can execute the TOP requirements without information from the TO

# Purpose And Use of the PJM/TO Matrix

- The matrix only applies to facilities for which PJM is the registered TOP and TP
- The matrix shows the tasks performed by the member TO in order for PJM to fulfill the reliability requirements and cites the specific agreement or manual where those tasks are prescribed
- Where the TO is shown as a responsible entity, the matrix shows the tasks PJM will perform in order for the member TO to be compliant
- The Matrix is the guiding document for PJM's Reliability Audits of TOs performed every three years

# Purpose And Use of the PJM/TO Matrix

- The NERC Functional Model requires that “all transmission elements” of the bulk electric system are the responsibility and under the control of one and only one transmission planner, planning authority and transmission operator
- Since PJM member TOs assist PJM in carrying out its responsibilities it is essential to clearly define relationships to ensure all compliance obligations are met and compliance activities are properly coordinated
  - NERC/RRO Audits require clarity and definition

## Purpose And Use of the PJM/TO Matrix

“The Matrix is intended to clarify the assignment of tasks based on the unique relationship between PJM and its Member TOs as defined in the TOA and OA and described in detail in various PJM Manuals. The Matrix does not create any new obligations for PJM or its members, but is simply a cross-reference to indicate where the assignment of various reliability tasks is documented”

*PJM/Transmission Owners NERC Standards Compliance Matrix*, as approved by the TOAAC

All of the requirements in the Matrix come directly from reliability standards or the PJM manuals. No new requirements are included, however, in some cases the manuals contain additional detail not included in the standard

Category	EOP	Purpose	Ensure plans, Facilities, and personnel are prepared to enable System restoration from Blackstart Resources to assure reliability is maintained during restoration and priority is placed on restoring the Interconnection.
Standard Number	EOP-005-2		
Requirement Number	R1		
Approved BOT/FERC Standards	Each Transmission Operator shall have a restoration plan approved by its Reliability Coordinator. The restoration plan shall allow for restoring the Transmission Operator's System following a Disturbance in which one or more areas of the Bulk Electric System (BES) shuts down and the use of Blackstart Resources is required to restore the shut down area to service, to a state whereby the choice of the next Load to be restored is not driven by the need to control frequency or voltage regardless of whether the Blackstart Resource is located within the Transmission Operator's System. The restoration plan shall include: <i>[Violation Risk Factor = High] [Time Horizon =Operations Planning]</i>		
A/S	S		
Assigned or Shared TO Tasks	1. Each Member TO shall have a restoration plan that supports restoring the Transmission Operator's System following a Disturbance in which one or more areas of the Member TO's BES shuts down. 2. The Member TO shall send the Member TO restoration plan to PJM for approval.		
Shared PJM Tasks	PJM will review, recommend revision and/or approve submitted Member TO Restoration Plans.		
Audit Questions	1. Do you have a restoration plan that supports for restoring the Transmission Operator's System following a Disturbance in which one or more areas of the Member TO's BES shuts down? 2. Is it approved by PJM?		
Evidence of Compliance (What auditors will be looking for)	Exhibit your restoration plan and show that it covers a plan to reestablish its electric system in a stable and orderly manner in the event of a partial or total shutdown of its system, including necessary operating instructions and procedures to cover emergency conditions, and the loss of vital telecommunications channels. 2. Show evidence of approval by PJM which may include emails or logging on the PERCS website.		
Reference Documents	M-3 Transmission Operations (Rev. 42), Section 1.2-Responsibilities for Transmission Owner's Operating Entity, Section 5- Notification for Loss of PJM EMS Capacity  M-36 System Restoration (Rev. 18) Section 8-System Restoration Plan Guidelines; Section 1.1-Policy Statements, PJM Member Actions, Attachment G: Coordination of Restoration Plan with PJM Internal and External Neighboring Entities		



# TO Operator Responsibility

- **Awareness**
  - Member TO company system operators need to maintain an awareness of the delineation of responsibilities and assignment of tasks within PJM TO/TOP Matrix

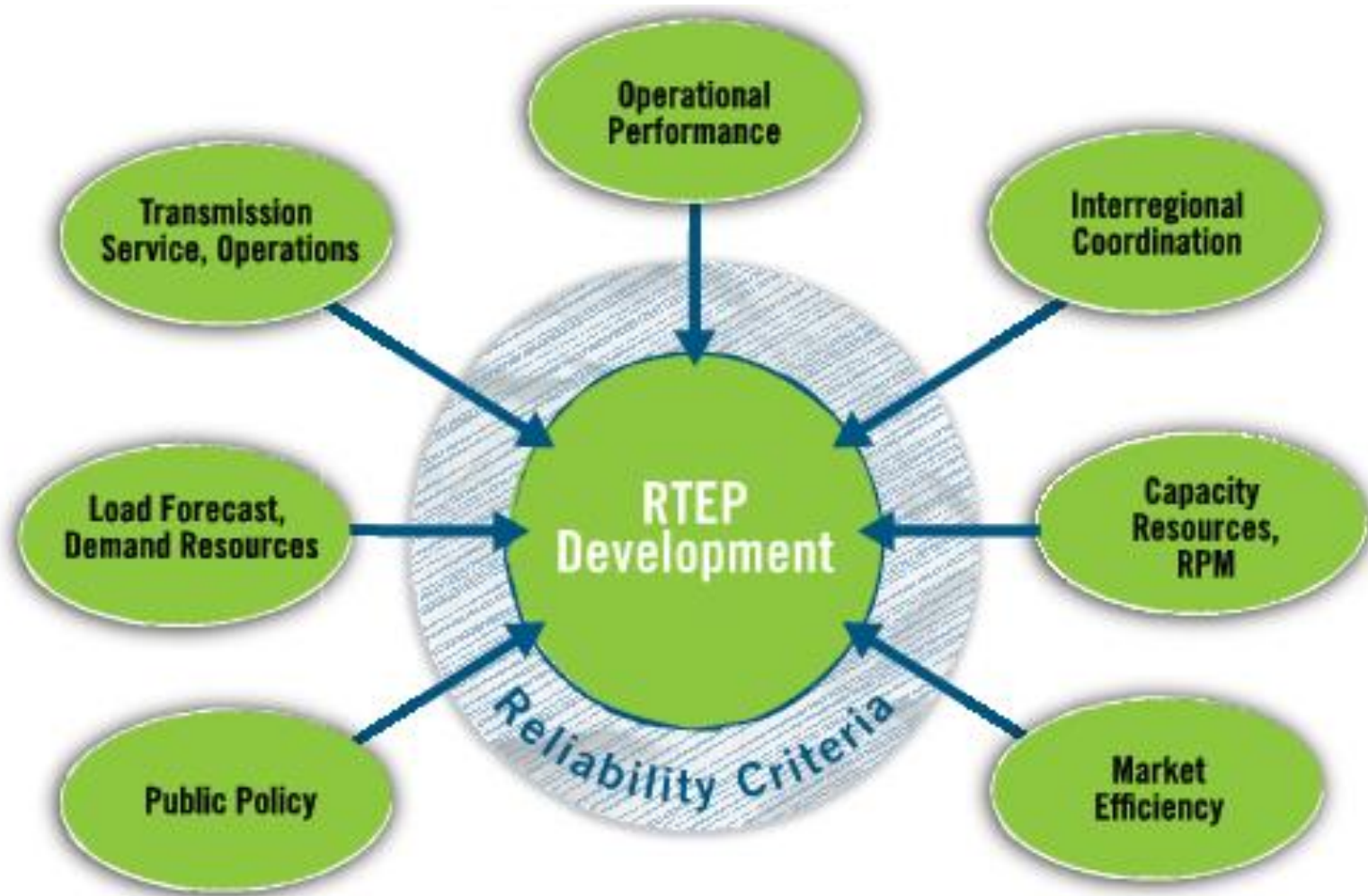
# RTEP

# Regional Planning Objectives

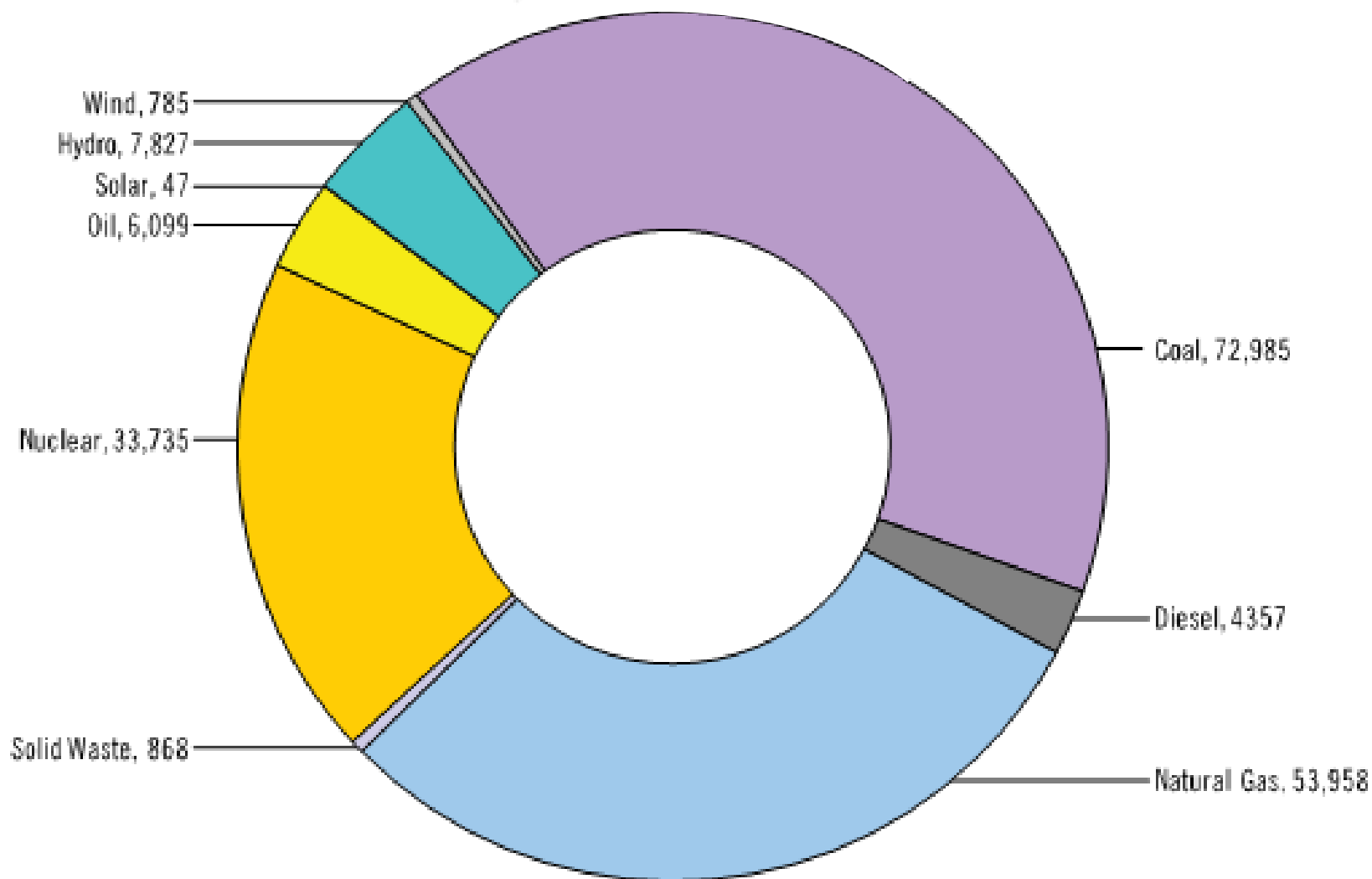
- 15 year outlook to identify reliability standards violations
- Test the transmission system against mandatory national standards and PJM regional standards
- Reliability and economic efficiency drivers\*
- Develop transmission reinforcements in collaboration with Transmission Owners
- Develop a unified Strategy for the entire PJM footprint – the RTEP
- Submit Plan to PJM's independent governing Board for consideration and approval



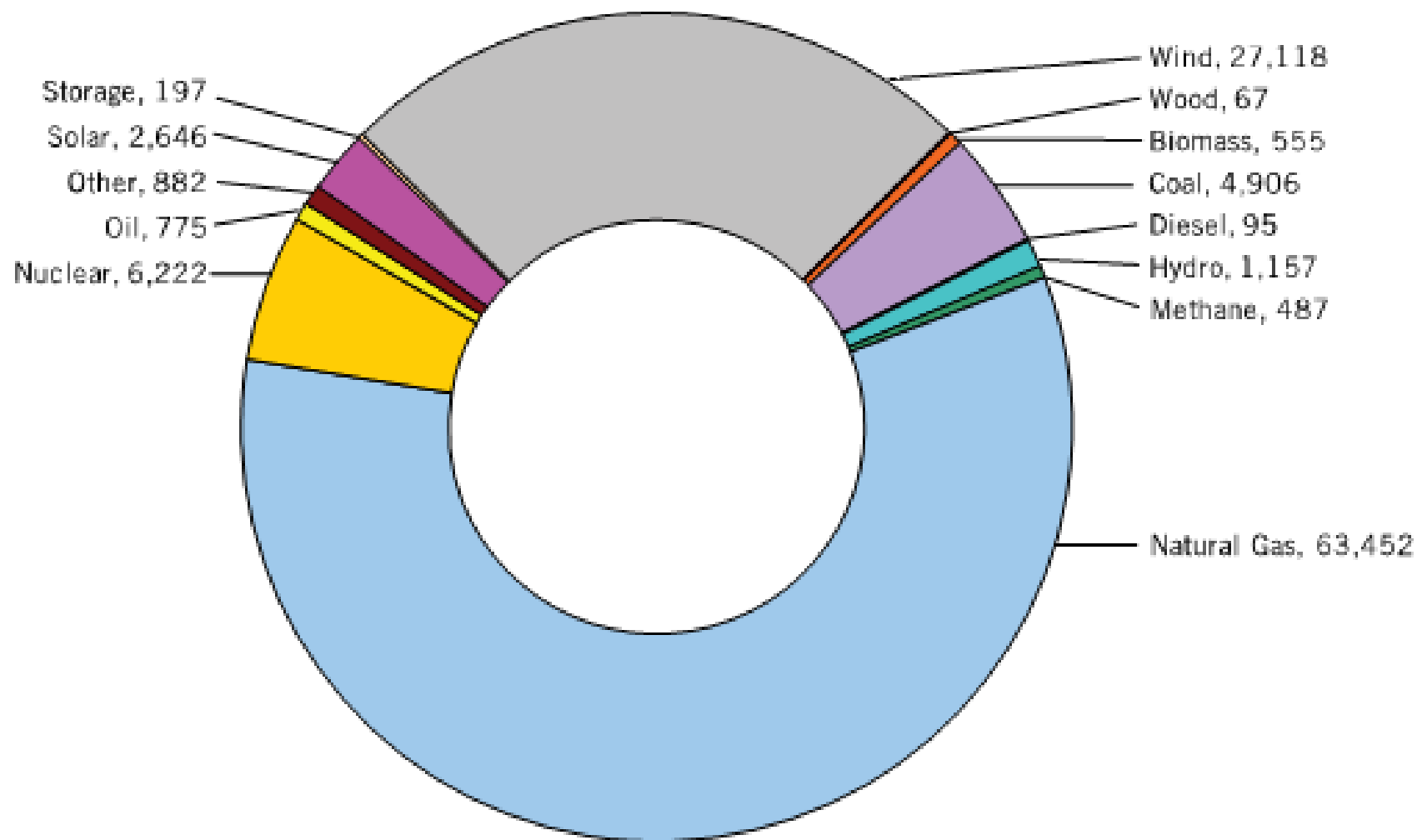
# RTEP Development Drivers



## Installed capacity Fuel Mix as of 12/31/12



# Fuel Mix for all Queued Generation Interconnection Requests since 1999



# Accessing the PJM RTEP Report

about pj | training | committees & groups | **planning** | markets & operations | documents

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## Planning



PJM's Regional Transmission Expansion Plan (RTEP) identifies transmission system additions and improvements needed to keep electricity flowing to 51 million people throughout 13 states and the District of Columbia. Studies are conducted that test the transmission system against mandatory national standards and PJM regional standards. These studies look 15 years into the future to identify transmission overloads, voltage limitations and other reliability standards violations. PJM then develops transmission plans in collaboration with Transmission Owners to resolve violations that could otherwise lead to overloads and black-outs. This process culminates in one recommended plan - one RTEP - for the entire PJM footprint that is subsequently submitted to PJM's independent governing Board for consideration and approval.

### RELATED INFORMATION

- Manuals
- 2011 Regional Transmission Expansion Plan Report
- Compliance
- Transmission Expansion Advisory Committee
- Regional Planning Process Task Force
- WEB Eastern Interconnection Planning Collaborative
- PDF Public Policy Considerations and Drivers
- PDF PJM Backbone High Voltage Transmission System
- PDF PJM Regional Transmission Expansion Planning Process - September 2010



This report is a comprehensive study of the planned system upgrades within PJM. It explains:

### System Upgrade Drivers

- Load growth
- Generation additions
- Generation deactivation

### Reliability Criteria Violations

- Transmission constraints
- Voltage limits

### Enhancements Needed

- New facilities
- Upgrades to existing facilities

- Introduction to FOTO
- Introduction to PJM
- **Member TO Training and Certification Requirements**



# Member Transmission Owner Operator Requirements

- **Initial Training Requirements**
  - PJM FOTO Course
    - Training is linked to each shared task on the Transmission Owner Task List
    - PJM provides training on all shared tasks; member companies provide training on company-specific tasks
  - Task Verification
    - Each operator must be verified as having the capability to perform each task at least one time (PER-005)
    - Verify within 6 months for new or changed tasks

# Member Transmission Owner Operator Requirements

- **Certification Requirements**

- PJM Transmission Certification
  - Certificate good for 3 years
  - May be renewed in 2 ways:
    - Re-test before the prior certificate expires
    - Over the 3 year period, accrue 140 CE hours (of which 30 must be simulation related)
- NERC Certification
  - 3 acceptable versions
    - Transmission (TO)
    - Balancing, Interchange and Transmission (BT)
    - Reliability Coordinator (RC)
  - Certificate good for 3 years
  - May only be renewed by CE hours (140/160/200, respectively)

# Member Transmission Owner Operator Requirements

- **Continuing Training Requirements**
  - Each operator must complete **32 hours** of emergency operations related training annually (PER-005)
- How can you meet these requirements?
  - PJM-provided training (in-person, online via LMS)
  - Company-provided training
  - Third-party, NERC-approved providers

# Summary

- Reviewed the structure of the Fundamentals of Transmission Operations (FOTO) course
- Defined PJM's role as a Regional Transmission Organization (RTO)
- Described the relationship between PJM and its Member Companies
- Identified the PJM Training and Certification requirements for Transmission Owner operators

# Questions

## Disclaimer:

PJM has made all efforts possible to accurately document all information in this presentation. The information seen here does not supersede the PJM Operating Agreement or the PJM Tariff both of which can be found by accessing:

<http://www.pjm.com/documents/agreements/pjm-agreements.aspx>

For additional detailed information on any of the topics discussed, please refer to the appropriate PJM manual which can be found by accessing:

<http://www.pjm.com/documents/manuals.aspx>

## Resources and References

- ISO/RTO Council. (n.d.) *Map*. Retrieved from <http://www.isorto.org/site/c.jhKQIZPBImE/b.2604471/k.B14E/Map.htm>
- NERC. (n.d.) *Functional Model*. Retrieved from <http://www.nerc.com/page.php?cid=2%7C247%7C108>
- NERC. (2008). *Glossary of Terms*. Retrieved from [http://www.nerc.com/files/Glossary\\_12Feb08.pdf](http://www.nerc.com/files/Glossary_12Feb08.pdf)
- PJM. (2012). *PJM Manual 40: Certification and Training Requirements (rev. 12)*. Retrieved from <http://www.pjm.com/~media/documents/manuals/m40.ashx>