Issues Tracking
• **Open Issues**
  – Post 2016 machine list to PJM.com
  – Complete, 2016 machine list posted to January 2011 TEAC meeting materials

• **New Issues**
Baseline Reliability Update
• Revision for Brady Project
• Initially identified in 2007 RTEP N-1-1 study of 2012 summer case
  – Overloads of Carson – Oakland 138 kV and Arsenal – Brunot Island 345 kV
• Initial projects to change scope ($291.3M):
  – B0501 - New Brady 345 kV substation and 345 / 138 kV transformer at Brady
  – B502 - New Underground Carson - Brady - Brunot Island 345 kV circuit
  – B0503 - Loop existing Carson - Oakland 138 kV into new Brady 138 kV substation
Duquesne Transmission Zone

• Revised recommended Solution:
  – Construct new Brunot Island to Carson 345 kV line.
  – Convert Forbes to 138 kV Supply.
  – Extend & recable existing Carson - Oakland 138 kV.

• Expected IS Date:
  – Phased in approach
  – 6/12 to convert Forbes & recable portion of existing Carson - Oakland
  – 6/13 to recable remainder of Carson-Oakland
  – 6/16 to complete 345 kV loop

• Estimated project cost: $188M
Supplemental Projects
• Replace two 345 kV circuit breakers at Goodings Grove TSS 116 on lines 11601 & 11602 with breakers with faster clearing times. (s0266)

• Estimated cost: $ 4.6 M

• Required IS Date: 6/1/2012
• Replace four 345 kV circuit breakers at Lockport TSS 108 on lines 10805 & 10806 with breakers with faster clearing times. (s0267)

• Estimated cost: $ 8.0 M

• Required IS Date: 6/1/2012
PJM Generation Scenario Analysis
• Study Scenario
  – Meet RPS requirements

• Sourcing Strategies
  – Meet RPS with PJM resources
  – Meet RPS with a combination of PJM resources and external resources

• Study Years

• Analysis Methods
What are the energy requirements to meet RPS requirements?
RPS Policies

www.dsireusa.org / January 2011

29 states + DC and PR have an RPS
(7 states have goals)

Renewable portfolio standard
Renewable portfolio goal
Solar water heating eligible
Minimum solar or customer-sited requirement
Extra credit for solar or customer-sited renewables
Includes non-renewable alternative resources

WA: 15% x 2020*
MT: 15% x 2015
MN: 25% x 2025 (Xcel: 30% x 2020)
OR: 25% x 2025 (large utilities)*
5%-10% x 2025 (smaller utilities)
NV: 25% x 2025*
CO: 30% by 2020 (IOUs)
10% by 2020 (co-ops & large munis)*
CA: 33% x 2020
UT: 30% by 2025*
AZ: 15% x 2025
NM: 20% x 2020 (IOUs)
10% x 2020 (co-ops)
HI: 40% x 2030
TX: 5,880 MW x 2015
HI: 40% x 2030

MN: 25% x 2025
MI: 10% + 1,100 MW 2015†
NY: 29% x 2015
OH: 25% x 2025†
WV: 25% x 2025†
VT: (1) RE meets any increase in retail sales x 2012,
(2) 20% RE & CHP x 2017
WI: Varies by utility; 10% x 2015 statewide
IA: 105 MW
IA: 105 MW
KS: 20% x 2020
MO: 15% x 2021
KS: 20% x 2020
MO: 15% x 2021
MO: 15% x 2021

SD: 10% x 2015
ND: 10% x 2015
MI: 10% + 1,100 MW 2015†
NY: 29% x 2015
OH: 25% x 2025†
WV: 25% x 2025†
MI: 10% + 1,100 MW 2015†
NY: 29% x 2015
OH: 25% x 2025†
WV: 25% x 2025†

ME: 30% x 2000
New RE: 10% x 2017
NH: 23.8% x 2025
MA: 22.1% x 2020
New RE: 15% x 2020 (+1% annually thereafter)
RI: 16% x 2020
CT: 23% x 2020
PA: ~18% x 2021†
NJ: 22.5% x 2021
MD: 20% x 2022
DE: 25% x 2026*
DC: 20% x 2020
DC: 20% x 2020
PR: 20% x 2035
PR: 20% x 2035
Maryland Renewable Requirement

- 20% by 2022
- Solar – 2% by 2022
New Jersey Renewable Total

- 22.5% by 2020-2021
- Solar Electric 5,316 GWh by 2025 – 2026
• 25% by 2025-2026
• Solar 3.5% by 2025 – 2026
• 20% by 2020
• Solar 0.4% by 2020
Pennsylvania Totals

- ~18% by 2020-2021
- Tier I: ~8% by 2020-2021 including PV
- Tier II: 10% by 2020-2021
- Tier I resources include: PV, solar-thermal, wind, low-impact hydro, geothermal, biomass, biologically derived methane, coal mine methane and fuel cells
- Tier II resources include: waste coal, distributed generation, demand side management, large scale hydro, municipal solid waste, wood pulping, and IGCC
- For this study, PJM will account for Tier 1 resources only
• 25% alternative and renewable by 2025
• Eligible Resources Include: Solar Thermal Electric, Photovoltaic, Landfill Gas, Wind, Biomass, Hydroelectric, Geothermal Electric, Fuel Cells, Municipal Solid Waste, other non-renewable alternative energy resources (coal technology, coal bed methane, natural gas, fuel from coal gasification, pumped storage hydro), Anaerobic Digestion, Small Hydro, Biodiesel
• Given the “other non-renewable alternative energy resources”, this study will assume half of the requirement
• 15% of base year (2007) by 2025
• PJM study will assume half of the target because the requirement is based on 2007 sales less average nuclear production between 2004 - 2006, only applies to IOU’s and double credit for wind and solar
North Carolina Totals

- 12.5% by 2021
- Solar – 0.2% by 2018
- PJM study will assume half of the target because energy efficiency and CHP can account for up to 25% through 2021 and 40% thereafter
Ohio Totals

- 12.5% by 2025
- Solar – 0.5% by 2024
• 10% by 2015
• Eligible Resources Include: Solar, Thermal Electric, Photovoltaic, Landfill Gas, Wind, Biomass, Hydro, Geothermal Electric, Municipal Solid Waste, CHP/Cogeneration, Coal fired with CCS, Gasification, Anaerobic Digestion, Tidal, Wave Energy
• 25% by EY 2026
• Solar – 6% by EY 2026
• Eligible Resources Include: Solar, Thermal Electric, Photovoltaic, Landfill Gas, Wind, Biomass, Hydro, Biodiesel
Renewable Energy Requirement Assumptions

- Updated based on PJM 2011 Load Forecast
- RPS information taken from [www.dsireusa.org](http://www.dsireusa.org)
- West Virginia assumed to be half because alternative resources can be used which include: pumped storage, waste coal, double credit for renewables, certain coal technology and energy efficiency
- Virginia assumed half because requirement is based on 2007 sales less nuclear production, it only applies to IOU’s and there is a double credit for wind and solar.
- North Carolina - Assumed half because energy efficiency and CHP can count for up to 25% through 2021 and 40% thereafter, and out of state resources can count for up to 25%
- Pennsylvania – “Tier I” only i.e. wind, solar, biomass, geothermal

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Total Renewable Energy Required

Renewable Energy Required in PJM (GWh)

- Total PJM
- Percent of PJM Load
Wind and Solar Requirements in PJM (MW)

Assumes a 30% cap factor for wind
Assumes a 12% cap factor for solar
How will the analysis source the renewable resources?
Wind Potential

- United States Department of Energy – National Renewable Energy Laboratory Data
- Offshore wind speed from NJ to VA (not pictured above) ranges from 8 – 9 m/s
- Data source
NREL Wind Sites
* Note that offshore is in the > 40% capacity class according to NREL data
Sourcing – Where should the resources be located?

- Appalachian Mountains
  - Amount that could be added may be limited due to geography

- Magnitude in OH, Indiana, Illinois

- Offshore
  - Low Offshore – less – 4,000 MW (radial)
  - High Offshore – 10,000 MW (networked)

- External
  - No external delivery
  - Serve PJM through \( \frac{1}{2} \) internal + \( \frac{1}{2} \) external resources
• Continue to develop sourcing assumptions
  – Where would the units be connected?

  – How much generation should be added?
    • Initially assume a 30% capacity factor to estimate the amount of wind that would need to be connected.
    • The amount of generation will be validated through production cost simulations to ensure we meet the RPS requirements

  – Where should the generation be added?
    • Use queue information to determine location of wind generation for PJM for initial analysis that studies meeting RPS with PJM resources
    • Use PJM queue information and identified MISO locations for analysis that studies meeting RPS with PJM resources and external resources
    • Select sites with the best wind resource data
Sourcing Approach for Years Considered

- **2021** (start to add wind & offshore)
  - 2000 MW in Offshore Zone
  - Add Wind in other zones (use RPS as guide for magnitude)
  - Approximately 7200 MW solar (assuming a 12% capacity factor)
  - Add Natural Gas Units

- **2026** (need more capability than just wind)
  - 2000+ MW in Offshore Zone
  - Add additional Wind in other zones (use RPS as guide for magnitude)
  - Approximately 11,000MW solar (assuming a 12% capacity factor)
  - Add Natural Gas Units
  - Add two Nuclear Units
## Sourcing Assumptions

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<th>2021</th>
<th>2026</th>
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<td><strong>Target Installed Nameplate based on State Targets</strong></td>
<td>Solar 7,000</td>
<td>Solar 11,000</td>
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<td>Wind 32,000</td>
<td>Wind 41,000</td>
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<td><strong>Total</strong></td>
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<td>52,000</td>
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<td><strong>Forecast Restricted Demand</strong></td>
<td>166,560</td>
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<td>(2011 PJM Load Forecast)</td>
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<td><strong>Installed Reserve Margin</strong></td>
<td>15%</td>
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<tr>
<td><strong>Installed Capacity Needed</strong></td>
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<td><strong>Installed Capacity Credit</strong></td>
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<td>Wind 4,800</td>
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<td><strong>Total</strong></td>
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<td><strong>Current Installed Capacity</strong></td>
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<td><strong>Additional Capacity Needed</strong></td>
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* Assumes 30% capacity factor for Wind and 12% capacity factor for solar
** Assumes 10,000 MW of DR
*** Assumes 38% for solar and 15% for wind
### Sourcing Assumptions

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<tr>
<th>Renewable Sources</th>
<th>Capacity Factor</th>
<th>Percentage Distribution</th>
<th>2021 Installed MW Target</th>
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To Be Determined
• Develop power flow cases based on study assumptions

• Power flow screening to identify potential limiting facilities
  – Study will focus on 345 kV and above transmission for western wind resources and 230 kV transmission for off-shore wind injections

• Develop production cost simulation models
  – Model future renewable resources linked to the appropriate wind profiles
• Production Cost Simulations
  – Used to confirm sufficient energy from renewable resources to meet RPS
  – Used to identify constrained facilities inhibiting delivery of energy

• Develop transmission solutions to mitigate issues identified through the production cost simulations

• Reliability Criteria Testing
  – Generation Deliverability
  – Light Load
  – NERC Category C (except C3)
Email RTEP@pjm.com with any comments
Next Steps
Review Issues Tracking