# Renewable Integration Study Report

**Recommendations for PJM Stakeholder Consideration**

<table>
<thead>
<tr>
<th>NO.</th>
<th>REFERENCE</th>
<th>SUBJECT AREA</th>
<th>RECOMMENDATION</th>
<th>PRIORITY</th>
</tr>
</thead>
</table>
| 1   | Major Conclusions and Recommendations  
      *Executive Summary - Section 4 (pp 8-9)* and Section 15 (page 43) | Adjustments to Regulation Requirements | The amount of regulation required by the PJM system is highly dependent upon the amount of wind and solar production at that time. It is recommended that PJM develop a method to determine regulation requirements based on forecasted levels of wind & solar production. Day-ahead & shorter term forecasts could be used for this purpose. |        |
| 2   | Major Conclusions and Recommendations  
      *Executive Summary - Section 4 (pp 8-9)* | Renewable Energy Capacity Valuation | Capacity value of renewable energy has a slightly diminishing return at progressively higher penetration, and the LOLE/ELCC approach provides a rigorous methodology for accurate capacity valuation of renewable energy. PJM may want to consider an annual or bi-annual application of this methodology in order to occasionally adjust the applicable capacity valuation of different classes of renewable energy resources in PJM. |        |
| 3   | Major Conclusions and Recommendations  
      *Executive Summary - Section 4 (pp 8-9)* | Mid-Term Unit Commitment Using Better Forecasts | It is recommended that PJM consider using such a mid-range forecast in real-time operations to update the commitment of intermediate units (such as combined cycle units that could start in a few hours). The wind & solar forecast feature can be added to the current PJM application called Intermediate Term Security Constrained Economic Dispatch (IT SCED) which is used to commit CT’s and guides the Real Time SCED (RT SCED) by looking ahead up to two hours. This would result in less reliance on higher cost peaking generation. |        |
## Major Conclusions and Recommendations

**Executive Summary - Section 4 (pp 8-9) and Section 15 (pp 47-48)**

### Exploring Improvements to Ramp Rate Performance

It is recommended that PJM explore the reasons for ramping constraints on specific units, determine whether the limitations are technical, contractual, or otherwise, and investigate possible methods for improving ramp rate performance.

## Topics for Further Study

**Executive Summary - Section 16 (pp 48-49)**

### Impacts of Reduced Energy Revenues for Conventional Power Plants

The study results show that as renewable penetration increases, wind and solar resources will displace energy production from conventional coal and gas generating plants. Energy revenues for conventional generation resources will decline significantly. To remain economically viable, these plants would either need to receive a larger share of their revenues from a capacity market or perhaps increase energy prices to help cover fixed costs. Alternatively, some conventional plants may not be viable and would be retired. It is suggested that PJM investigate the potential consequences of reduced capacity factors and energy revenues on its conventional generation fleet.

### Flexibility Improvement for Conventional Power Plants

There is an emerging body of industry knowledge on methods for increasing the flexibility of power plants that have traditionally been operated as baseload units. A recent NREL study summarizes recent progress. It is suggested that PJM investigate possible methods that could be applied to existing units with limited ramping or cycling capabilities.
Another potential source of system flexibility is from wind and solar plants. In the past decade, manufacturers have made significant advancements in control methods that can make plant power output responsive to grid-level controls, including frequency response and down-regulation. A recent NREL report summarizes several possible concepts related to frequency control. Given the growing industry concern over declining frequency response performance of the Eastern Interconnection, it would be prudent for PJM to investigate how wind and solar plants could contribute to frequency response, and work towards interconnection requirements that ensure PJM will continue to meet its grid-level performance targets.