PJM Renewable Integration Study
Consultant Recommendations

Intermittent Resources Task Force
September 22, 2014
## PJM Renewable Integration Study (PRIS) Background

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• **Executive Summary** is posted on the IRTF web page
• Recommendations from the Executive Summary are summarized on the following slides. *Note that report recommendations and suggestions are those of the report authors.*
• Market Implementation Committee on 5/7/2014 approved an IRTF Charter change to add the following assignment:
  – Assess operational and reliability impacts in the event of high market penetration
• Review recommendations from the recently completed PJM Renewable Integration Study and present to the MIC a plan for how they ought to be addressed, if any. Schedule: Proposed approach presented to MIC by August 2014.
• July 21 – reviewed report recommendations with IRTF
• August 11 – issued survey to IRTF email distribution list
• September 5 – deadline for survey responses
• September 22 – presented survey results to IRTF
#1 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 and solar production. Day-ahead and shorter term forecasts could be used for this purpose.*
#2. 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 methodology in order to calibrate its renewable capacity valuation methodology in order to occasionally adjust the applicable capacity valuation of different classes of renewable energy resources in PJM.*
#3. Mid-Term Commitment Using Better Wind and Solar Forecast

- Wind and solar forecasts are much more accurate in the four- to five-hour-ahead timeframe than in the current day-ahead commitment process. 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 and 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.
#4. Exploring Improvements to Ramp Rate Performance

- It is recommended that PJM explore the reasons for ramping constraints on specific units, determine whether the limitation are technical, contractual, or otherwise, and investigate possible methods for improving ramp rate performance.
#5. 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.*
#6. 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.*
#7. Expanding System Flexibility through Active Power Controls on Wind & Solar Plants

- 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.
• Respondents asked to rank the importance of each recommendation on this scale:
  1. Very important, should be addressed within the next year
  2. Medium importance
  3. Low importance
  4. An issue to be monitored, but no action required at this time
  5. Not a concern for the PJM region

• 17 responses received, representing 85 companies
## IRTF Survey Results

### Recommendations:
1. Adjustments to Regulation Requirements
2. Renewable Energy Capacity Valuation
3. Mid-Term Unit Commitment Using Better Forecasts
4. Exploring Improvements to Ramp Rate Performance

### Topics for Future Study:
5. Reduced Energy Revenues for Conventional Power Plants
6. Flexibility Improvement for Conventional Power Plants
7. Active Power Controls on Wind & Solar Plants

### Survey Results Table

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#5 voted highest priority

#4 and #7 also high/med

- **High**
- **Medium**
- **Low**
- **Monitor**
- **No Concern**

- **High/Med**
- **Low or less**
• These three recommendations were highest priority for PJM stakeholders:
  o #5 Impacts of Reduced Energy Revenues for Conventional Power Plants
  o #4 Exploring Improvements to Ramp Rate Performance
  o #7 Expanding System Flexibility through Active Power Controls on Wind and Solar Plants
• #5 (impact of reduced energy market revenues) should be considered in ongoing Capacity Market discussions
• #7 is being addressed by the Enhanced Inverter subgroup of the Planning Committee
• **Recommend addressing #4**
• Present survey results and IRTF’s recommendation to MIC for its consideration at the October 8th meeting.
#1 Recommendation: Adjustments to Regulation Requirements

[Company] agrees that it is important to understand the amount of regulation that is necessary in order to ensure reliability while accounting for the amount of wind and solar production. It will be very important to differentiate between the need for additional regulation and the need for additional ramp capability. The purpose of regulation is to maintain system frequency. While regulation can also be used to overcome significant changes in renewable production, it is a very expensive way to procure ramp. Therefore, in addition to this recommendation, [Company] would also like to see PJM pursue some of the other options identified in the study that identify limitations in ramp rates and hopefully eventually create greater incentives for those resources commensurate with their ability to provide ramp capability.

We desire that the discussions around this topic should start soon but implementation of any adjustments may not be required "within the next year".

Wind and solar do not have a significant impact on regulation requirements at this time, but this could become more important as penetration levels grow. At higher levels, it would be inefficient to increase regulation requirements for all hours because there are many hours during which wind and solar will have no affect (or only in one direction). For example, additional up-regulation is not needed when wind output is low because wind output can only go up, solar will have no affect on regulation at night. It is therefore relatively straightforward to procure additional regulation only when it may be needed based on forecasted wind and solar production.

Purchasing extra regulation by procuring energy from generation with inferior flexibility and availability should not be borne by load. These units should pay for the extra regulation that they require much the same as reactive upgrades must be procured by new generation that cannot provide var support itself.

This is consistent with the effort to reduce operating reserve charges for all PJM members.

This should be sent to the OC as part of any overall regulation review.

PJM already monitors its regulation performance (for compliance with NERC BAL reliability standards). If scores indicate a need to increase the quantity of regulation we are confident PJM will do so.
#2 Recommendation: Renewable Energy Capacity Valuation

Capacity has broader implications in PJM systems, and an ELCC view will recognize winter performance for wind. Hopefully stakeholders will entertain a more complete conversation of renewables and capacity value.

We consider the existing provisions for the valuation of our wind assets just and reasonable. We feel that they do a good job of determining the appropriate amount of Installed Capacity that should be considered in the RPM. We also note the ongoing Capacity Performance initiative, where renewable capacity valuation will likely be a topic for discussion, and suggest either considering this change as part of that initiative, or tabling this discussion until after the Capacity Performance has been finalized and implemented. We would suggest the latter; tabling it until after the Capacity Performance initiative has been completed.

We support the continued use of a rigorous LOLE/ELCC method for capacity valuation using a significant duration of high-quality data. While we do not expect the capacity value to change much from year to year, establishing a clear process and a well-defined dataset for doing a LOLE/ELCC capacity valuation every year or two would be a very good idea. In addition, with increased emphasis on capacity performance during winter periods, PJM should establish capacity values on a seasonal basis.

If done, this should be applied to all resources.

PJM is required to perform LOLE analysis. This may be a valid recommendation, but we expect the Planning Committee to determine at what point additional analysis is needed.
• #3 Recommendation: Mid-Term Unit Commitment Using Better Forecasts
  • Seems this is a cost-saving opportunity.
  • Renewable energy production forecasts degrade the farther out you move from the relevant time period. Additionally, as the amount of renewable production increases in PJM, this variability in time period forecasts will also increase. We agree that improving the way in which PJM commits intermediate units will help to address this variability in forecast in a far more efficient manner than the current method of using CT’s alone. While the study does not demonstrate such a scenario, we would also note that as the amount of renewable energy production increases, CT commitment alone may not be sufficient. Therefore, we think that this recommendation, along with the other recommendations that identify limitations in ramp rates and hopefully eventually create greater incentives for those resources commensurate with their ability to provide ramp capability
  • We would like to see these discussion start soon however it does not seem necessary to implement changes "within the next year". Better forecasts will further limit the need for significant use of regulating reserves and will also better deal with existing variability in demand and variable resources.
  • The use of updated wind, solar and load forecasts for intraday unit commitment has been shown to be valuable in other systems, leading to a lower cost of serving load and more efficient dispatch. Adding this feature to IT SCED is a very good idea.
  • This will result in uplift created by worse min run times and other parameter limits of base generation compared to peakers. Bad idea.
  • This is consistent with PJM's efforts to improve overall system operations and dispatch efficiency. The short term SCED becomes more important as more renewable capacity is added.
  • This seems like something PJM would already be doing. Also - the report does not address minimum load and high voltage issues that can occur overnight.
  • PJM already has the ability to perform this analysis. And we note that PJM already does not dispatch a majority of CTs with DA schedules because doing so tends to reduce RT LMP thereby potentially increasing balancing operating reserve charges.
#4 Recommendation: Exploring Improvements to Ramp Rate Performance

- Valuable, and relevant to more than just renewables integration. If PJM or MIC can pursue regardless of a renewables justification, all the better.
- We agree that increased ramp capability will help with the integration and greater penetration of renewable generation. In parallel with this recommendations, we would also like to see PJM explore ways in which it can create incentives for resources to offer greater amounts of ramp capability. While it may be helpful to identify the reason for ramping constraints, providing the proper incentives for resources to offer in more ramp capability will send a market signal to generators allowing for the most efficient procurement of the necessary ramp capability.
- It was clear from the PRIS report that the ramp rate constraints that were imposed by fossil generation were an impediment to variable resource integration. Review of what the causes and possible fixes are for ramp rate constraints would be very helpful information. This effort could benefit from including the exploration of market mechanisms, as well as technical possibilities, for alleviating ramp rate constraints. Experience in control rooms of other RTOs indicate that ramp limitations are likely a problem that may require attention even without consideration of any significant amount of variable resource integration.
- We rate this item highly not because we believe that ramping is a concern for PJM, but so that PJM can be prepared to react to NERC and others on this topic. Ramping capability has become a big topic of discussion in California and some other regions, but we suspect that the concern is at least partially created by self-scheduling preferences, historical operating practices, or economic limitations rather than by technical issues. Understanding the true situation and starting to examine the cost of improving ramp rate performance would allow PJM to get out ahead of this discussion.
- If PJM markets put enough value to the capability of a generator to ramp (at all, or more quickly) the capability should be there.
- While there may be some value in this evaluation, PJM surveys have indicated that a majority is due to managing emissions, O&M expenditures, etc. There is no substantive reward for increasing the ramp rate.
#5 Topic for Future Study: Impacts of Reduced Energy Revenues for Conventional Power Plants

- Don't know that it needs to finished in a year, but given capacity performance expectations it is an issue that needs to be addressed.
- I think this should be done within the next five or so years.
- If a resource is displaced, load should not pay to keep that resource around plus the new inflexible/unavailable renewable resource.
- Low gas prices are the most significant driver of energy prices and revenues. Gas prices have already had significant impact, so we believe that the concerns about energy revenue impacts are already quite well understood. The impact of renewables is small and will not be significant until much higher penetration levels. So we believe that this issue is already being addressed through the capacity market stakeholder process and other venues, and no special action with regard to renewables is needed at this time.
- Perhaps this is a different kind of problem? Or will be better addressed in a Capacity market review?
- This is an issue not just due to renewables, but also due to the explosive growth of DR. It is worthy of effort and believe it is currently being addressed in PJM stockholder efforts.
- This should be moved into capacity discussions.
- We agree that it is important that all generation resources remain economically viable, we are concerned with any issue charge that would irrationally increase capacity market or energy market prices. As renewable generation increases, a greater amount of demand will be satisfied at a lower price on the aggregate supply curve, ultimately reducing the amount born by end-use customers, absent the presence of renewable generation. [Company] believes the current market design for energy and ancillary services along with the capacity market (RPM) provide a good basis for driving investment in the best resource mix in order to meet demand and other environmental factors.
#6 Topic for Future Study: Flexibility Improvement for Conventional Power Plants

• Seems to have value regardless of renewable energy role.

• In line with our previous comments, we think that increased flexibility will most certainly assist with the increased penetration of renewable energy production. In general, we would like to see the PJM Market provide the incentive for resources to offer in additional flexibility, such that it drives an efficient market outcome. We also note that the pending capacity performance initiative includes elements that may help to address this issue.

• Similar comment for the issue of "exploring improvements to ramp rate performance"

• This seems very similar to Recommendation #4, so perhaps those efforts could be combined. It would certainly be a good long-term strategy to look at whether retrofits to increase flexibility of baseload units are cost effective and practical. Initial results in other regions may suggest that this is not the most cost effective strategy, but it would be good to know.

• The costs for these improved operations flexibilities would probably need to be captured in RPM

• I think it would be helpful for PJM to do some stakeholder education around this topic.

• Much of the perceived 'inflexibility' of these units is based on permits, engineering, design and construction. PJM recently performed a survey which seems to bear this out.
• **#7 Topic for Future Study: Expanding System Flexibility through Active Power Controls on Wind & Solar Plants**
  
  Also a topic in the Enhanced Inverter effort. But frequency response discussion has to be fleet-wide, and not solely an issue for renewables.
  
  We agree that system reliability is important and that PJM must have the capability necessary to adequately address voltage issues. However, we also note that this issue is addressed through the inverter subgroup discussion.
  
  Given the concern about frequency response in the Eastern Interconnection, research in on this topic is timely. Given appropriate incentives, wind plants are technically capable of providing primary frequency response and regulation (as has been demonstrated in ERCOT, PSCo and other regions), but this requires some additional costs and controls. Utility-scale solar plants can have similar capabilities. But because wind and solar are used primarily as energy resources and are motivated to maximize energy production, appropriate incentives (such as a frequency response ancillary product) may need to be investigated.
  
  PJM is indirectly looking at this through the enhanced inverter effort actively being addressed at the Planning Committee.