Meeting Renewable Energy Targets in the West at Least Cost: The Integration Challenge

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Background

- Western Governors' Association project
- Funded in part by The Energy Foundation
- Project team
  - Regulatory Assistance Project
  - Exeter Associates
  - National Renewable Energy Laboratory
- Draws from existing studies, experience to date

Context

- State renewable energy standards in place today will more than double renewable resources in the Western U.S. by 2022, compared to 2010.
- 37 balancing authorities in WECC
- No organized energy markets outside CA and AB
- WGA commissioned a paper to explore ways to reduce costs to Western electricity consumers for integrating wind and solar installed under state policies, barriers to adopting these cost-saving measures, and possible state actions.

Paper Under Review by Technical Committee

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Robert Zavadil, EnerNeX

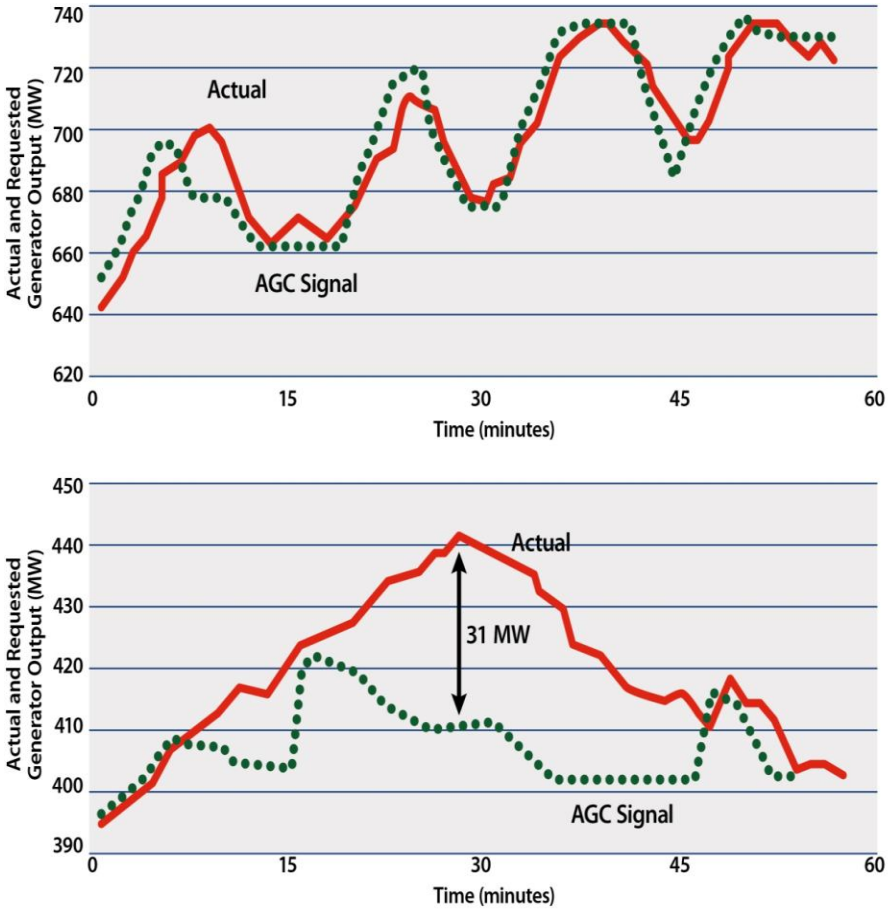
** Serving in his role as an advisor to SMUD, not as a WECC Board member.*

Nine ways to save: operational and market tools, flexible demand- and supply-side resources

1. Expand subhourly dispatch & scheduling
2. Facilitate dynamic transfers between balancing authorities
3. Implement an energy imbalance market
4. Improve wind and solar forecasting
5. Take advantage of geographic diversity of resources
6. Improve reserves management
7. Retool demand response to complement variable generation
8. Access greater flexibility in the dispatch of existing generating plants
9. Focus on flexibility for new generating plants

First a word about cost-causation and integration cost

- Many types of generation impose integration costs
  - New, inexpensive base-load
    - Causes other units to incur cycling cost, lower capacity factor
  - Large units that increase contingency reserve
    - Increases cost of contingency compliance for others in the pool
  - Conventional plants that impose regulation cost
  - Wind and solar
- Integration costs are not always based on cost-causation (but should be)



Milligan, M.; Ela, E.; Hodge, B. M.; Kirby, B.; Lew, D.; Clark, C.; DeCesaro, J.; Lynn, K. (2011). Cost-Causation and Integration Cost Analysis for Variable Generation. NREL Report No. TP-5500-51860

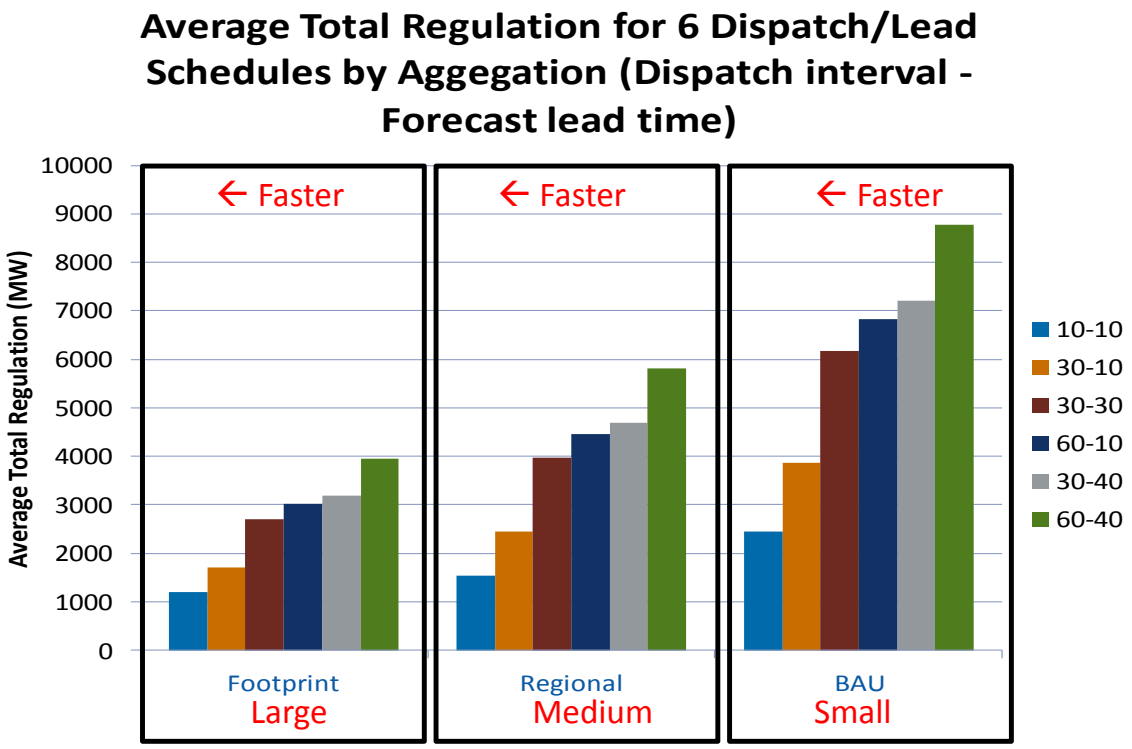
Expand subhourly dispatch & intra-hour scheduling

How it works – Transmission customers submit schedule changes for intervals shorter than an hour and shortly before the scheduling period

Key benefit – Reduce regulating reserves by up to nearly 75% depending on footprint size

Implementation barriers

- Inconsistent intra-hour practices
- Metering, control center operations and software
- Cost to implement
- Not coordinated with settlement
- No intra-hour markets outside CA and AB



Clarifying terms

1. Different meanings for intra-hour scheduling
   - Submit one schedule at the top of the hour that can be divided into, say, two 30-minute segments. The schedule can't be changed (or it can only be increased).
   - Submit a different schedule every 5 minutes or every 15 minutes for the next 5-minute or 15-minute period
2. When intra-hour scheduling can be used
   - I-TAP - Only for unexpected events
   - Other regions in the U.S. - Routinely
3. Standardization between balancing authorities
   - Lack of consistent scheduling intervals and protocols in West limit value of intra-hourly scheduling

Not all intra-hour scheduling practices are created equal.

	When Locked Down?	When Activated?	Rolling?	Standard Protocols?	Bilateral or Market-wide?
Joint Initiative	Top of the hour	Unusual events only	No	Yes	Bilateral
Western Standard Practice	Top of the hour	Focus on unusual events	No	No	Bilateral
Eastern RTO/ ISO Target Coordination	15 minute advance	Standard practice	Yes	Yes	Market-wide
Energy Imbalance Market	10 minute advance	Standard practice	Yes	Yes	Market-wide

- **Recommendations**
  - Encourage expansion of JI's intra-hourly scheduling activities beyond use for unexpected events
  - Promote subhourly dispatch and scheduling for all entities
  - Foster standardization among Western balancing authorities, allowing new schedules beyond just at the top of the hour
  - Evaluate costs, benefits and impacts of extended pilots on the need for reserves, particularly for regulation
  - Commission an independent analysis of equipment and labor costs of transitioning to subhourly dispatch and intra-hourly scheduling for all transmission providers in the West
  - Consider how to assist smaller transmission providers to recover costs of transitioning to intra-hourly scheduling
  - Explore harmonized implementation of faster dispatch, scheduling, balancing and settlement across the Western Interconnection

Facilitate dynamic transfers between balancing authorities

How it works – Electrically "moves" load or generation to another balancing area, and can be event-only or systematic

Key benefits

- Enables access to flexibility in bilateral markets
- Joint Initiative implementation relatively inexpensive
- Geographic diversity (benefit limited if bilateral, not system-wide)

Implementation barriers

- May reduce utilization of existing transmission capacity
- More frequent, larger intra-hour power and voltage fluctuations
- Lack of automation of some reliability functions
- May impede calculation of system operating limits on T paths
- May increase T equipment wear and tear, reduce power quality

- **Recommendations**
  - Complete transmission provider calculations of dynamic transfer limits to help identify which lines are most restrictive
  - Determine priority for improvements to ease restrictions
  - Assess options and costs for additional transmission capacity and additional flexibility to facilitate more widespread use of dynamic transfers
  - Assess best approaches for integrating dynamic transfer limits into scheduling and operating practices
  - Conduct stakeholder outreach on implications of transfer limits and potential system impacts to help identify solutions
  - Automate reliability procedures such as voltage control and RAS arming (or increase staffing levels) to enable expanded use of dynamic transfers
  - Use near real-time data to calculate system operating limits to address concerns about potential violations of limits

Implement an energy imbalance market

How it works – Centralized market mechanism to:
1) Re-dispatch generation every 5 minutes to maintain balance, addressing generator schedule deviations & load forecast errors
2) Provide congestion management service by re-dispatching generation to relieve grid constraints

Key benefits

- Enables dispatch of generation and transmission resources *across* BAs to resolve energy imbalances
- Sumo wrestler: big and fast
- Full geographic diversity of load and generation

Implementation barriers

- Implementation cost and financing start-up
- Operational cost
- New operational practice
- Unresolved issues including:
  - Market operator
  - Governance
  - Regional tariff
  - Coordination agreements with reserve-sharing groups, CAISO and non-participants
  - Participation interest

- **Recommendations**
  - Undertake efforts to define the terms of a regional transmission tariff needed to implement an EIM
  - Explore financing options to enable entities to defer some of the start-up costs to future years and to better plan and budget for costs
  - Investigate the costs and benefits of regulated utilities participating in an EIM, including:
    - Potential reduction in integration costs
    - Enhanced reliability
    - Potential disadvantages of participation
    - Possible negative economic impacts for meeting renewable energy requirements in the absence of EIM participation

Improve reserves management

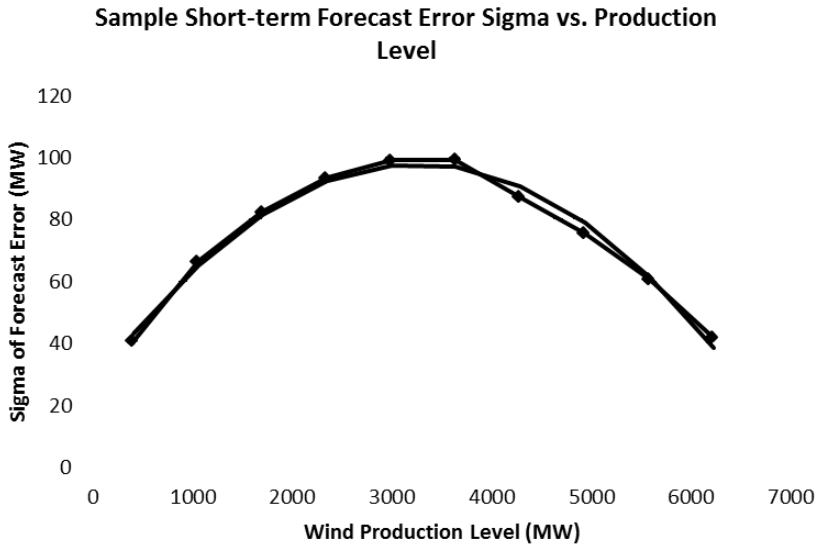
How it works – Fixed reserve for wind and solar is not appropriate or rational. Amount of reserves needed depends on conditions.
Options:

1) Reserve sharing
2) Dynamic calculations
3) Using contingency reserves for wind events
4) Controlling variable gen

Key benefit – Reduce cost while maintaining reliability

Implementation barriers

- New practice
- Research on best practices is needed



- **Recommendations**
  - Equip more conventional generating facilities with AGC
  - Expand reserve-saving activities such as ADI, expand limits
  - Ask WECC VGS to analyze dynamic reserve methods
  - Ask balancing authorities to explore dynamic reserve requirements to take into account wind and solar on the system and other system conditions
  - Develop coordinated or standardized rules for controlling variable generation that minimize economic impacts to wind and solar generators, limiting controls to situations where actions are needed to maintain system reliability or when accepting the generation leads to excessive costs
  - Consider different wholesale rate designs to encourage more sources of regulation

Improve wind and solar forecasting

How it works – Use of weather observations, metrological data, Numerical Weather Prediction models, and statistical analysis to generate short, medium, and long-term wind and solar forecasts

Key benefits

- Improves ability to schedule other resources around expected wind and solar availability
- Reduces total operating costs
  - Fewer reserves needed as experience and confidence are gained
  - Reduced fuel consumption, O&M costs and emissions

Implementation barriers

- Improving forecast accuracy
- Allowing for time to implement forecasts
- Collecting the necessary data
- Geographic diversity
- Incorporating variable generation forecasts in day-ahead schedules and dispatch

- **Recommendations**
  - Support government and industry initiatives to improve foundational models and data used for wind and solar forecasting
  - Encourage expanded use of forecasting by balancing authorities
  - Ask experienced balancing authorities to study the feasibility, costs and benefits of improvements to variable generation forecasts
  - Study the feasibility, costs and benefits of:
    - Using forecasts for day-ahead unit commitments and schedules, including updating schedules closer to real-time
    - More regional forecasts involving multiple balancing authorities or exchange of forecasts among balancing authorities
  - Ask balancing authorities:
    - If variable generation ramps are or will be of concern
    - Whether existing forecasting systems adequately predict variable generation ramps
    - Whether ramp forecasts for variable generation are under consideration

Take advantage of geographic diversity

How it works – Variations in output from individual wind and solar plants are reduced over a large geographic area.

Key benefits

- Lower aggregate variability of variable generation
- Reduced variable generation forecasting errors
- Decreased need for reserves

Implementation barriers

- Lack of available transmission capacity may naturally lead to resource concentration
- Increasing spacing between wind and solar plants may require more transmission capacity
- Limited in small balancing authority areas, except via transfers
- Trade-off: More variable generation capacity may be required to realize the same generation output

- **Recommendations**
  - Quantify the costs and benefits of geographic diversity in utility resource planning and procurement and in subregional and interconnection-wide studies
  - Investigate pros and cons of siting optimization software and whether it can be advantageously used in processes such as defining renewable energy zones and resource planning
  - Advocate for FERC transmission incentives for interstate lines that access renewable resources from regional renewable energy zones designated through a stakeholder-driven process in areas with low environmental conflicts
  - Design integration charges with geographic diversity in mind, if such charges are proposed or implemented
    - For example, levy integration charges only on energy imbalances (that is, energy deliveries higher or lower than scheduled) that are in the same direction as the system imbalance for that hour

Access greater flexibility in the dispatch of existing generating plants

How it works

- Output control range, ramp rate and accuracy, minimum run times, off times, and startup times are primary factors.
- Some plants can be retrofitted to increase flexibility by lowering minimum loads, reducing cycling costs and increasing ramp rates.
- There are economic tradeoffs between plant efficiency, opportunity costs, capital costs and maintenance expenses.
- Other practices discussed in the report, such as shorter scheduling intervals, help access flexibility of existing generating plants.

Key benefits – Expands operating range to complement wind/solar

Implementation barriers for retrofitting plants

- Fundamental limitations of technology and uniqueness of each plant
- Cost and uncertain payback
- Benefits may be comparatively small in aggregate compared to other ways to reduce integration costs, such as larger BAs and intra-hour scheduling.

- **Recommendations**
  - Analyze the potential for retrofitting existing, less flexible generating facilities
  - Provide appropriate incentives to encourage generating plant owners to invest in increased flexibility
  - Establish a flexible ramping ancillary service in areas where a shortage of ramping capacity is at least occasionally a problem
  - Require conventional generators to have frequency response capability, or define frequency response as a service that generators can supply for compensation
  - Commission a study to quantify cycling costs and identify mitigation measures in areas where plants may have to frequently cycle, regardless of the reasons

Focus on flexibility for new generating plants

How it works – More flexible capacity will be needed at higher levels of variable generation. Changes to resource planning and procurement frameworks can provide a greater focus on flexibility.

Key benefits

- More efficient system operation (having resources that can meet increased system variability needs)
- Increased utilization of zero variable-cost wind and solar
- Lower overall system operating costs

Implementation barriers

- Ability to assess how much flexible capacity exists, how much will be needed, and when
- Metrics & methods needed to assess flexibility of resource portfolios
- Resource procurement process not focused on flexible capability

- **Recommendations:**
  - Retool resource adequacy and planning analysis to reflect the economic benefit of flexibility service
  - Conduct flexibility inventory for existing resources
  - Evaluate the need for flexible capacity
  - Examine and amend guidance for:
    - Evaluating flex needs in utility planning and procurement
    - Benefits and costs of flexible capacity with increasing VG
    - Utility incentives/disincentives to invest in flexible supply
    - Demand-side resources to meet need for flexibility services
  - Review NERC IVGTF recommendations on metrics and methods for assessing flexibility and application
  - Use competitive procurement processes to evaluate alternative capacity solutions, specify capabilities, not technologies and fuels

Retool demand response to complement variable generation

How it works – Shift customer load up and down to complement variable renewable energy resources through direct load control and pricing with automation

Key benefits

- May be cheaper than supply-side resources or energy storage technologies
- Provides many ancillary benefits – e.g., more customer control over bills, more efficient delivery, more resilient power system

Implementation barriers – Demand response (DR) programs for variable generation integration are nascent, advanced metering infrastructure may not be in place, need better customer value propositions and better M&V, basis for customer payments (reserves costs) may not be transparent

- **Recommendations**
  - Consider DR as an essential complement to reliable and cost-effective deployment of variable renewable energy resources
  - Further develop and test customer acceptance of DR strategies that support frequent control of loads both up and down
  - Evaluate program designs that pay consumers based on real-time value of flexibility services, with automation
  - Consider potential value of enabling DR for integrating variable generation when evaluating advanced metering proposals
  - Cultivate strategies that earn consumer confidence in DR
  - Encourage participation of third-party DR aggregators
  - Allow DR to compete on a par with supply-side alternatives
  - Isolate and quantify costs of balancing services to value DR
  - Develop robust M&V processes
  - Examine ratemaking practices for features that discourage cost-effective DR

Next Steps

- April 9 – Comments due from Technical Committee (review draft sent March 25)
- April 12 – SPSC and public comments due
- April 19 – Target date for revised paper for WGA Staff Council
- May – Final report and stand-alone summary published
- Further discussion at June WGA and Western PSC meetings

Draft paper posted at

http://www.westgov.org/wieb/meetings/crepcsprg2012/04-12agen.htm

About RAP

The Regulatory Assistance Project (RAP) is a global, non-profit team of experts that focuses on the long-term economic and environmental sustainability of the power and natural gas sectors. RAP has deep expertise in regulatory and market policies that:

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- Allocate system benefits fairly among all consumers

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