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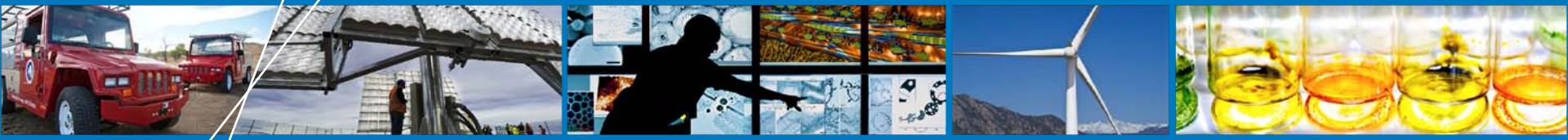
Meeting Renewable Energy Targets in the West at Least Cost: The Integration Challenge



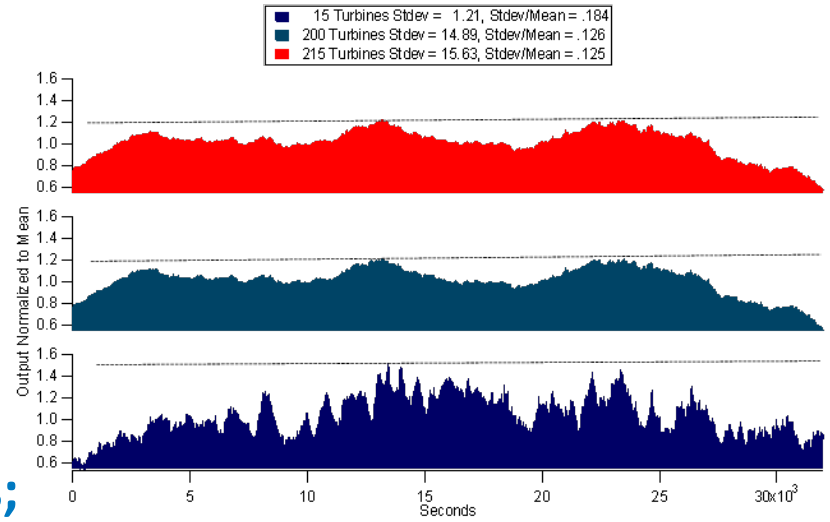
Lori Bird, NREL

California Energy Commission Workshop

June 11, 2012

Variability and Uncertainty of Wind and Solar

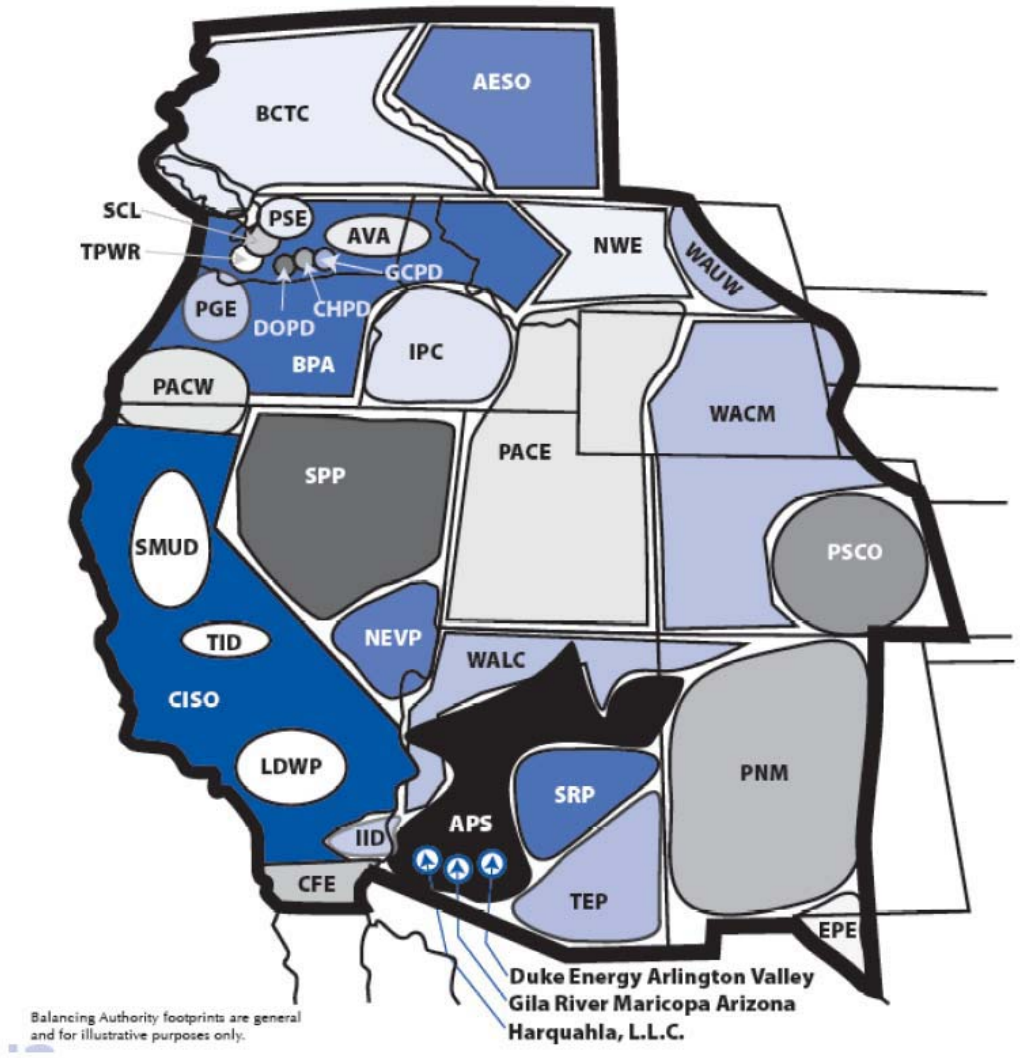
- **Wind and solar are:**
  - variable due to daily or seasonal patterns
  - uncertain due unknown changes in weather (i.e., no wind, cloud cover)
- **Variability is reduced with more resources spread over a wider area (weather is different)**
- **Wind – generally changes over hours; minimum load issue (e.g., wind available at night with low loads)**
- **Solar – significant minute-to minute change (from cloud cover)**



Source: NREL Wind Plant Data

(Approximately 8 hours)

Western U.S. Context



Hourly scheduling and many (37) balancing areas

Efforts underway to achieve balancing area cooperation and manage reserves regionally.

WGA Integration Report

- ***Meeting Renewable Energy Targets at Least Cost: The Integration Challenge*** **(http://www.westgov.org/index.php)**
  - Explores ways to reduce costs to consumers for integrating wind and solar, barriers to adopting measures and possible state actions
- **Project team**
  - Regulatory Assistance Project
  - Exeter Associates
  - National Renewable Energy Laboratory
- **Funded in part by The Energy Foundation. USDOE supported NREL's participation.**
- **Draws from existing studies, experience to date**

Technical Review Committee

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Charlie Smith, Utility Variable-Generation Integration Group

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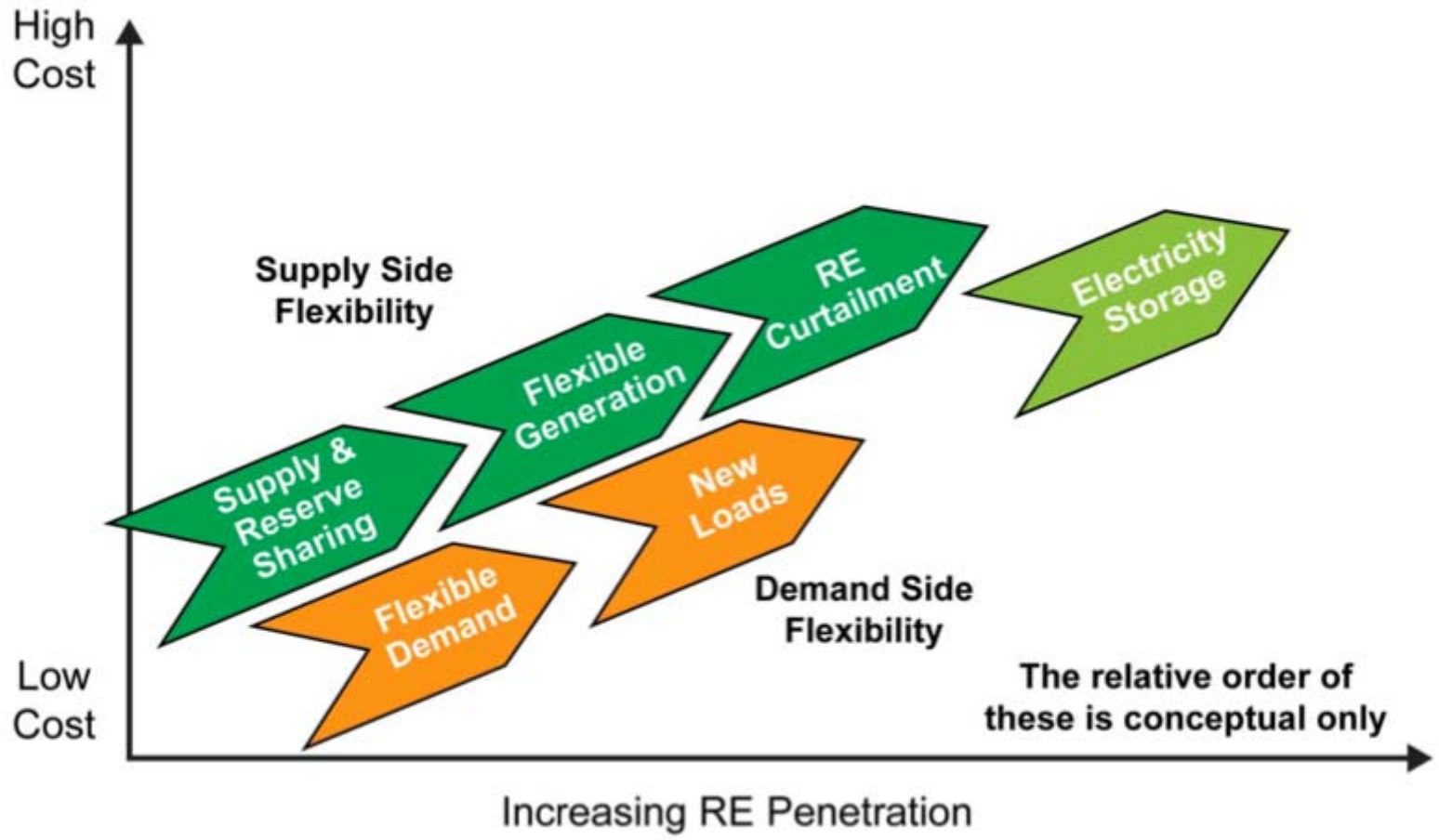
Options for Cost-Effectively Integrating Wind/Solar

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 weather, wind and solar forecasting
5. Encourage 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

Flexibility Options - Cost is a Consideration



Source: DOE

Dynamic Transfers

Facilitate dynamic transfers between balancing authorities

- Moving generation from the BA area where it physically resides to another area in real-time, for control by receiving BA
- Access to flexibility from a broader geographic area
- Joint Initiative implementation relatively inexpensive

Key recommendations

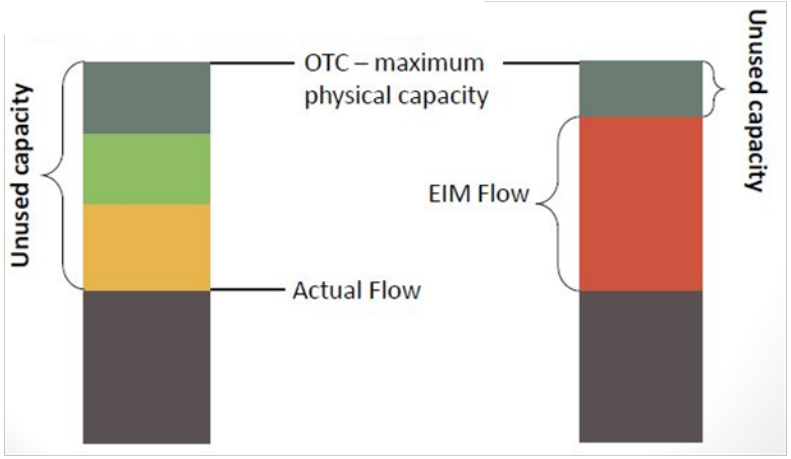
- Encourage BAs to use dynamic transfers
- Identify most receptive and most restrictive transmission lines
- Determine priority for improvements to ease restrictions
- Automate reliability procedures such as voltage control and RAS arming* to enable expanded use of dynamic transfers

**Remedial action schemes trip generation to maintain system reliability in the event of loss of transmission*

An Energy Imbalance Market

EIM Overview

- Centralized market to: 1) re-dispatch generation every 5 minutes to address generator schedule deviations, load forecast errors and 2) manage grid congestion
- Enables dispatch of generation and transmission *across* BA areas to resolve energy imbalances using the full geographic diversity of load and generation in the EIM footprint



Key recommendations

- Explore financing options
- Investigate in PUC proceedings costs and benefits to ratepayers
- Support continuing efforts to explore EIM governance
- Address concerns that an EIM could lead to an RTO
- Explore mechanisms to prevent market manipulation
- Define rates/terms for transmission service agreements for each entity
- Support West-wide efforts to design an EIM for broadest footprint

Improved Forecasting

Improve weather, wind and solar forecasting

- Use weather observations, meteorological data, Numerical Weather Prediction models, and statistical analysis to generate short, medium, and long-term wind and solar forecasts
- Advanced forecasting improves scheduling of other resources to reduce reserves, fuel consumption, O&M costs and emissions

Key recommendations

- Encourage expanded use of variable generation forecasting by BAs and forecasting improvements
- Study feasibility of using forecasts for day-ahead unit commitments/ schedules and schedule updates
- Encourage regional forecasts or exchange of forecasts among BAs
- Review whether existing forecasting systems adequately predict ramps

Alstom 2010.

Encourage Geographic Diversity

Geographic diversity reduces variability

- Variations in output from wind and solar plants are reduced over a large area
- Diversity lowers aggregate variability and forecast errors, reducing reserves needed

Key recommendations

- In transmission plans and utility resource plans/RFPs, consider siting wind and solar to minimize variability of aggregate output and better coincide with load profiles
- Investigate pros/cons of siting optimization software
- Support right-sizing of interstate lines (increasing project size, voltage, or both to account for credible future resource needs) that access renewable resources from zones designated through a stakeholder-driven process – when project benefits exceed costs

Improved Reserves Management

Reserves Management Options

- reserve sharing
- dynamic calculations
- using contingency reserves for wind events
- controlling variable generation

Key recommendations

- Expand reserve-sharing activities (e.g., ADI), expand limits
- Ask BAs to explore dynamic reserve requirements
- Perform statistical analysis to determine benefits if reserves for wind and contingency reserves can be shared
- Equip more conventional generation with automatic generation control (AGC); evaluate benefits of AGC for wind vs. revenue lost during curtailment

Complementary Demand Response

- Shift customer load up and down to complement wind and solar through direct load control and real-time pricing with automation
- DR may be less expensive than supply-side resources and energy storage technologies

Key recommendations

- Consider DR to complement variable energy resources
- Test value propositions to assess customer interest in strategies for frequent control of loads both up and down
- Consider potential value of enabling DR for integrating variable generation when evaluating advanced metering
- 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 in utility resource planning and acquisition
- Examine ratemaking practices for features that discourage cost-effective DR – e.g., demand charges that penalize large customers for higher peaks when they shift loads away from periods of limited energy supplies and revenue models that tie utility profits primarily to energy sales

Increased Flexibility of Generation

- **Access greater flexibility in the dispatch of existing generating plants**
  - Some plants can be retrofitted to increase flexibility by lowering minimum loads, reducing cycling costs and increasing ramp rates.
- **Focus on flexibility for new generating plants**
  - Requires rethinking resource adequacy analysis to reflect the economic benefit of flexibility service
  - Changes to resource planning and procurement frameworks

Key recommendations

- **Conduct a flexibility inventory for existing resources**
- **Analyze the potential for retrofitting less flexible generating plants**
- **Review incentives/disincentives for plant owners to invest in increased flexibility**
- **Identify strategies to minimize or avoid cycling**
- **Explore development of a flexible ramping ancillary service to take advantage of fast-response capabilities**
- **Examine and amend guidance for evaluating flexibility needs in utility resource planning**
- **Use competitive procurement processes to evaluate alternative flexible capacity solutions**

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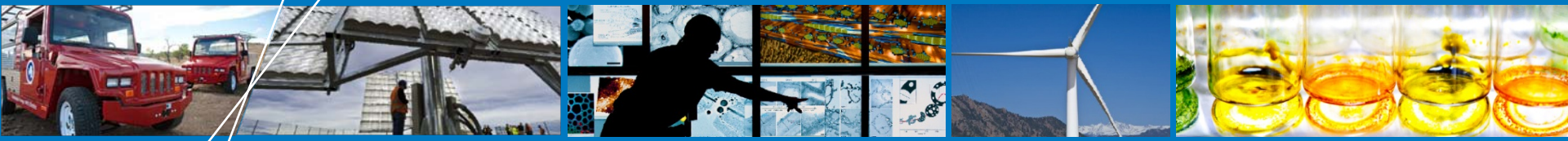

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