

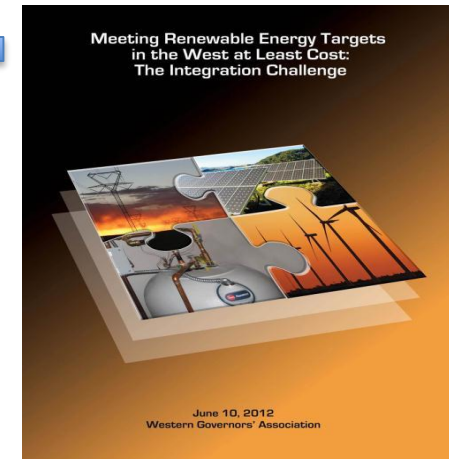
Leveraging Today's Technology to Teach the Duck to Fly

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Meeting Targets at Least Cost (WGA/RAP/NREL – June 2012)

- Expand Sub-hourly Scheduling ←
- Facilitate Dynamic Transfers
- Implement EIM
- Improve Forecasting
- Leverage Geographic Diversity
- Improve Reserves Management
- Retool Demand Response
- Use Flexibility of Existing Generation
- Flexibility in New Gas Generation →



Clean Energy Keeps the Lights On

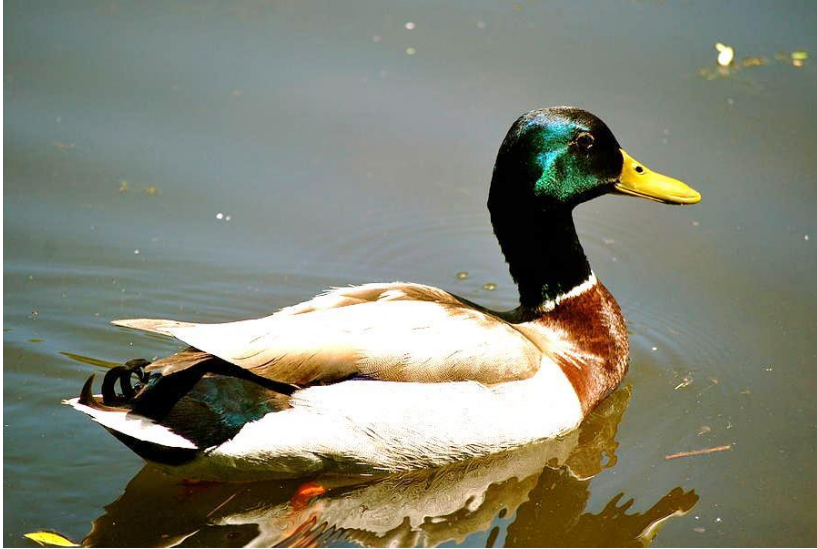
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"Our models found no technical difficulties accommodating much higher levels of variable wind and solar energy, while fully preserving reliability."
— Brattle Group (2013), for the Texas Clean Energy Coalition

Studies sponsored by utilities, government, and nongovernmental organizations and executed by highly regarded technical experts over the last four years have concluded that: renewable penetrations beyond current state renewable portfolio standards (RPS) can be accommodated with current electric system flexibility; proven technologies and practices can dramatically reduce the cost of operating high penetration, variable renewable energy (VRE) portfolios; and the studies that examined very high renewable penetrations found that these same technologies and practices can improve system flexibility and enable the electric system to operate reliably with renewable penetrations well above 50 percent. Each of the studies surveyed in this document recommends investment in additional distribution and transmission system infrastructure as well as changes to electric system operations, markets, and planning to achieve reliability

Studies supported by technical experts from PJM, General Electric (GE) Energy Solutions, Energy and Environmental Economics (E3), the Brattle Group, KEMA, the International Energy Agency (IEA), Imperial College London, Massachusetts Institute of Technology (MIT), and the National Renewable Energy Laboratory (NREL) have concluded that electric systems can be operated reliably with levels of VRE of 50 percent or more. PJM, for example, asserts that with adequate transmission additions and some additional regulation reserves, the PJM system will have no reliability issues with VRE penetrations of 50 percent. E3's study commissioned by several California utilities says that no reliability issues arise in California in meeting the current 33-percent RPS if expected transmission and generation investments are made, and that VRE levels of 40 and 50 percent can be accommodated, but the evolution of system operations will be required to minimize the cost of

Guess What: Ducks Can Fly



A duck in water has very much the shape of the CAISO graphic. The “fat body” floats, and the tall neck breathes.

A duck in flight stretches out its body and straightens its neck in order to reduce wind resistance.

Our job is to straighten this duck out.



Ten Strategies To Align Loads to Resources (and Resources to Loads)

1. Targeted energy efficiency
2. Orient solar panels
3. Use solar thermal with storage.
4. Manage electric water heat
5. Require new large air conditioners to include storage
6. Retire older inflexible power plants
7. Concentrate demand charges into “ramping” hours
8. Deploy energy storage in targeted locations
9. Implement aggressive demand response programs
10. Use inter-regional exchanges of power

Not every strategy will be applicable to every utility.

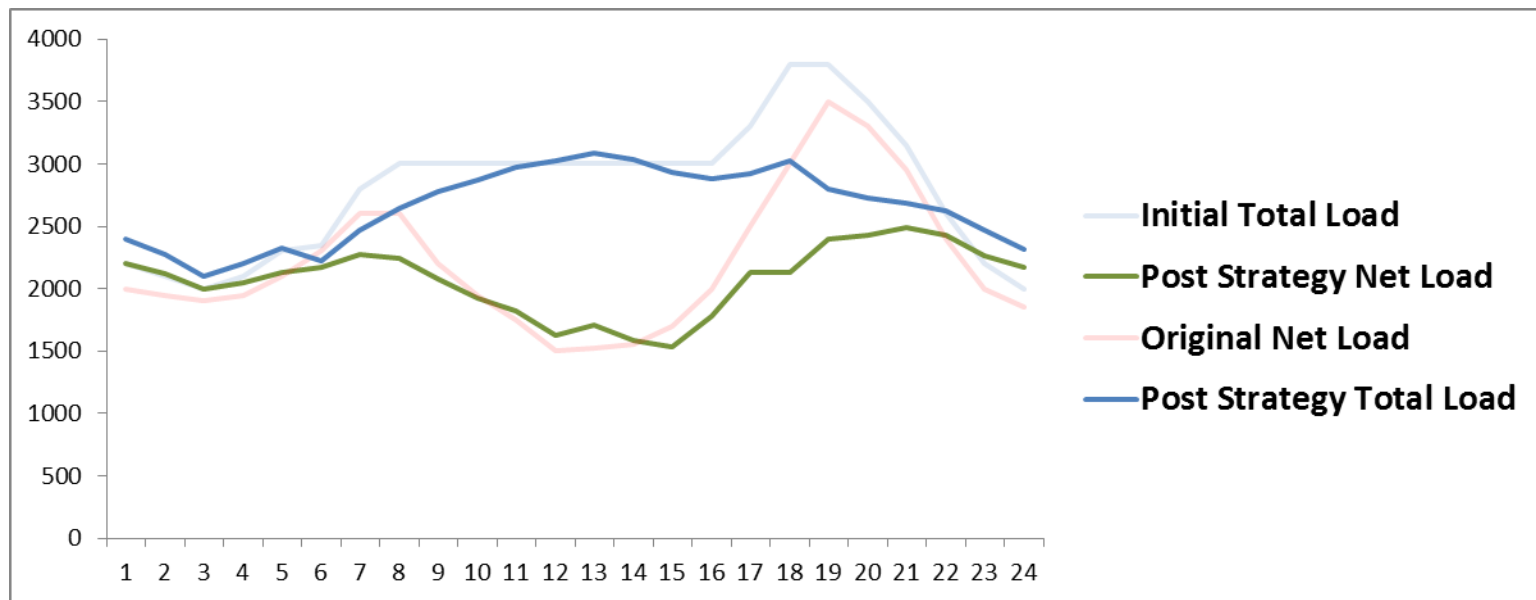
How Did We Do?

Pre-Strategy, without Solar/Wind: 73% LF

Pre-Strategy, with Solar/Wind: 63% LF

Post-Strategy, with Solar/Wind: 83% LF

Hourly Ramp: 340 MW vs. 400 today, and 550 w/o strategies



Two Questions

How well do we use today's info tech?
Will energy be scarce?



Resource Materials:

The Least Cost Integration Challenge:

<http://www.raonline.org/document/download/id/5041>

Teaching the Duck to Fly:

<http://www.raonline.org/document/download/id/6977>

Clean Keeps the Lights On:

<http://www.raonline.org/document/download/id/7175>

Regulatory Considerations Associated with Expanded
Adoption of Solar (w/ NREL):

<http://www.raonline.org/document/download/id/6891>

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:

- Promote economic efficiency
- Protect the environment
- Ensure system reliability
- Allocate system benefits fairly among all consumers

Learn more about RAP at www.raonline.org

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