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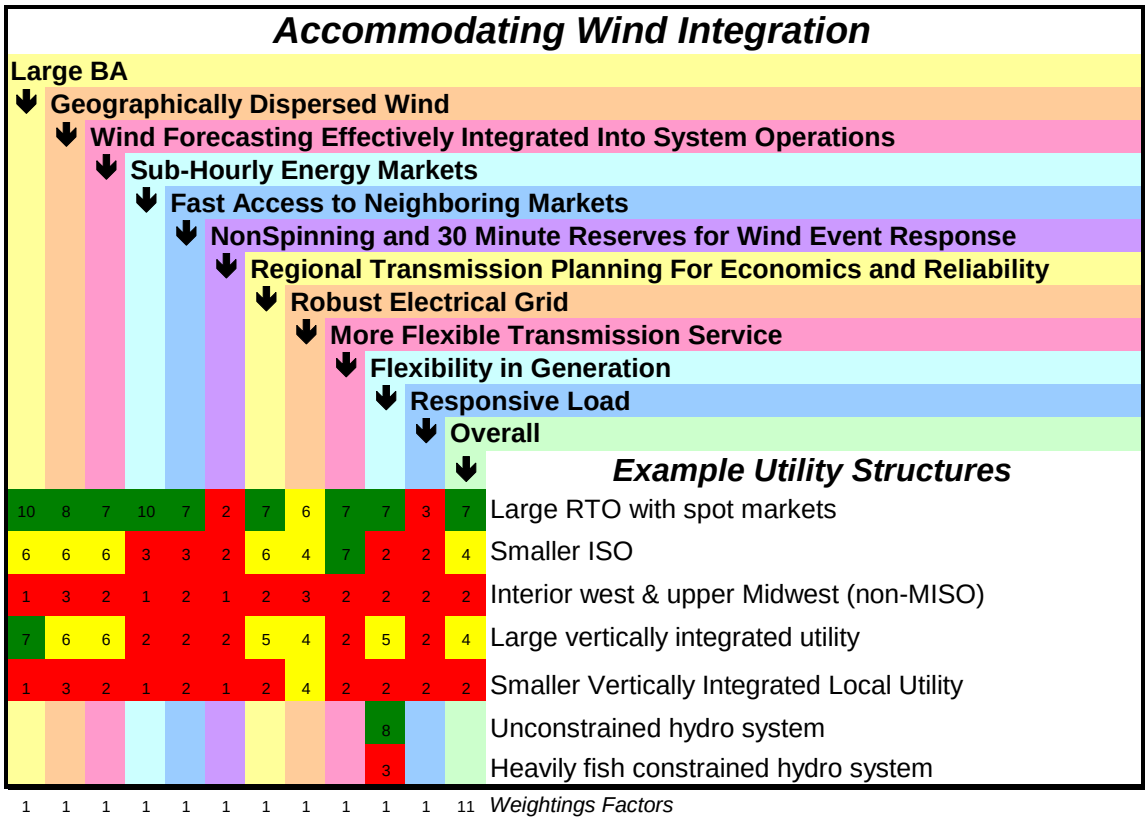
System Evaluation Tool

The ability of a balancing area (BA) or region to accommodate large amounts of wind can be quantified with the use of a System Evaluation Tool. This tool will be introduced in a WindPower 2009 paper to be published later this year[i] and is based on a 2008 paper by Gramlich and Goggin[ii] The tool allows a reviewer to numerically rate a BA in eleven areas that are important for reliably integrating variable resources at least cost. Comparisons of different BAs are possible as well as evaluating a single BA. Example ratings are provided which demonstrate how the tool might be used.



The System Evaluation Tool helps quantify and structure assessment of accomidating wind integration.

The System Evaluation Tool is a spreadsheet based instrument for assessing how accommodating the structure of a balancing area (BA) or region is to the integration of large amounts of wind generation. The judgments are necessarily subjective but the subjectivity is limited and provided with structure. The evaluator provides a numeric rating between 1 and10 for each BA in eleven areas: one is the poorest performance and ten is the best. Numeric weightings are provided color codes: below 3.5 is red, between 3.5 and 6.5 is yellow, above 6.5 is green. The model calculates the overall rating, applying weighting factors for each category. The evaluator can choose to give different

weighting factors to each category. Sub-hourly markets could be given twice as much weight as responsive load (or half as much) for example. In this example all categories are given equal weight.

The figure provides example evaluations for five hypothetical utility structures. The eleven categories are:

Large BA

Large geographic and electrical size makes it easier to integrate large amounts of wind because of diversity and aggregation benefits. The largest of today's BAs might be rated a 9, the smallest a 1.

Geographically Dispersed Wind

Geographic dispersal of wind generation within the BA reduces net variability. Concentrating all wind generation in a small area increases correlation among wind plants and therefore increases net variability.

Wind Forecasting Effectively Integrated Into System Operations

Advanced wind forecasts that are integrated into system operations can reduce costs by reducing reserve requirements and improving the unit commitment and economic dispatch of the conventional generation fleet.

Sub-Hourly Energy Markets

Sub-hourly energy markets provide access to the physical response capability of the conventional generators. Limiting generators and loads to hourly schedules artificially increases the need for expensive regulation.

Fast Access to Neighboring Markets

Similar to sub-hourly energy markets within a BA, sub-hourly scheduling with neighboring BAs allows neighbors to both reduce net variability and share generation response capability.

NonSpinning and 30 Minute Reserves for Wind Event Response

Large wind events are similar to conventional generation contingencies in frequency and size. Their slower speed makes them easier to deal with but reliability rules often prevent inexpensive reserves from being used and forces the use of very expensive regulation.

Regional Transmission Planning For Economics and Reliability

Interconnection wide transmission planning that focuses on economic benefits as well as reliability requirements can greatly reduce the cost of delivered power and wind integration.

Robust Electrical Grid

Regional transmission plans are not useful unless they are turned into transmission resources and a robust, uncongested grid.

More Flexible Transmission Service

Effective conditional firm transmission and redispatch services can help compensate for a somewhat inadequate transmission system.

Flexibility in Generation

BAs with excessive base load generation with high minimum loads and little ramping speed or range have a difficult time responding to load or wind variability.

Responsive Load

Responsive load is only beginning to be encouraged and utilized, especially for fast response to reliability events.

Overall

The tool calculates the overall capability ranking based on the individual assessments and the weighting factors.

The examples presented are all hypothetical. The value of the tool is that it supports the evaluation of individual BAs as well as comparing the relative capabilities of several BAs. A regulator could use the tool as part of a process designed to identify needed improvements in market structures and reliability rules as well as in transmission and generation facilities.

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[i] *The Impact of Electric Industry Structure on High Wind Penetration Potential*, WindPower 2009, Michael Milligan, Senior Researcher, National Renewable Energy Laboratory, Brendan Kirby, Consultant, National Renewable Energy Laboratory, Robert Gramlich, Policy Director, American Wind Energy Association, Michael Goggin, Electric Industry Analyst, American Wind Energy Association

[ii] *The Ability of Current U.S. Electric Industry Structure and Transmission Rules to Accommodate High Wind Energy Penetration*, 7th International Workshop on Large Scale Integration of Wind Power and on Transmission Networks for Offshore Wind Farms, Robert Gramlich, Policy Director, American Wind Energy Association, Michael Goggin, Electric Industry Analyst, American Wind Energy Association