CHUGACH ELECTRIC ASSOCIATION, INC.

Wind Integration Costs Using the R.W. Beck Hourly Dispatch Model

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R·W·BECK

An SAIC Company

Major Production Cost Model Inputs

- Hourly load shape
- Monthly load forecast
- Monthly natural gas price forecast
- Operating characteristics of thermal generating resources (heat rate curve, min capacity, max capacity, min up and down times, etc.)
- Operating characteristics of hydro generating resources
- Monthly hydro energy available
- Hourly wind shape

Major Model Assumptions (thermal)

- Hydro energy is used for peak-shaving
- +/- 5 MW requirement for frequency regulation in every hour
- Additional 15 MW of downward regulation required (for distribution feeder or transformer outage)
- 5 up/20 down regulation can be carried by SPP
- Spin requirements are 42 MW through 2014, 18 MW thereafter (can be carried by any hydro or thermal unit)
- Outages are known (scheduled and forced).

Major Model Assumptions (wind)

- 52.8 MW wind project, about 30% capacity factor
- Hourly expected wind energy is known
- Intra-hour variation is known (i.e. for each hour, the model knows the expected, minimum and maximum wind capacity)
- 100% of expected wind energy is backed by spin (from any hydro or thermal resource)
- 100% of intra-hour variation is carried by a CT
- Example:
  - Hour x: Expected wind: 35 MW, max wind: 40 MW, min wind: 30 MW
  - Model will commit resources to meet 35 MW spin (exclusive of system spin requirement), and
  - +5/-5 MW reserved on a CT for intra-hour variation (inclusive of wind spin requirement)

Model Methodology

- Monthly hydro energy is allocated to each day to give smooth residual load curve (load less expected wind energy less hydro energy)
- Remainder of dispatch is on a daily basis:
  - Hydro is dispatched to give smooth residual load curve (load less expected wind less hydro)
  - Thermal resources are committed to meet +5/-20 system regulation requirement
  - Thermal resources are committed to meet intra-hour wind variation requirement
  - Thermal resources are committed to meet load plus system and wind spin requirements
  - Commitment schedule is validated – checks for over-commitment (e.g. if a Frame 7 is committed for load/spin, a Frame 5 likely can be de-committed).
  - Committed resources are dispatched to minimize fuel consumption

Major Findings

- Wind integration cost is mostly the additional fuel expense to operate gas turbines for wind variability
- Wind project uses about 1.0 Bcf of gas for integration (net savings are about 0.5 Bcf)
- Integration costs are around $50-60 per MWh plus $40-50 per MWh (Chugach estimate) for the cost of a facility to provide an on-site variable gas supply
- Higher gas prices marginally change the value of wind because higher gas prices increase the value of wind and integration costs proportionally