Generation Adequacy with Variable Generation

Energy Systems Integration Group
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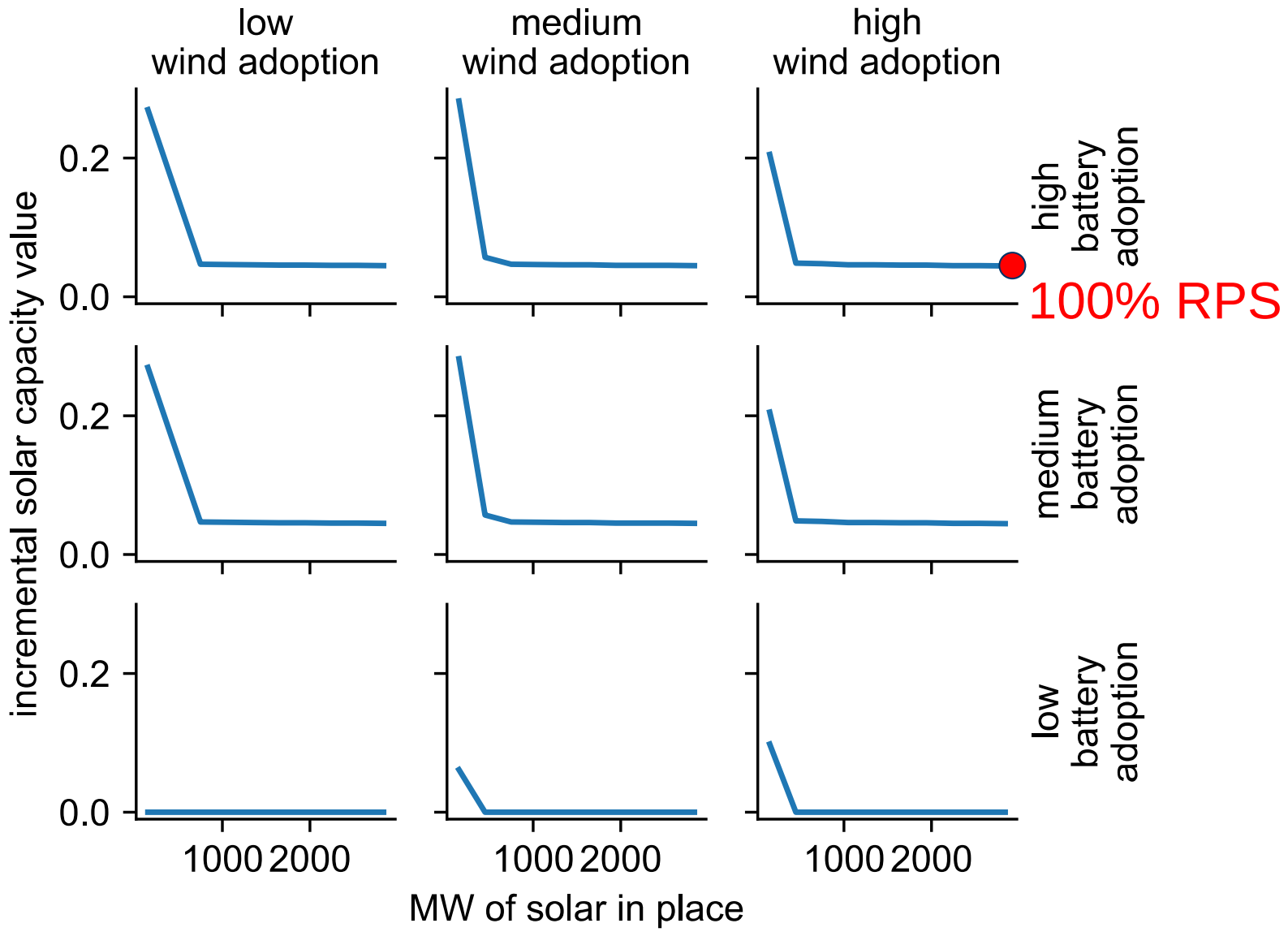
Hypothesis

- Capacity value of variable generation depends on what else has been built
- Effect on system costs also depends what else has been built
  - May be a more important measure than capacity value

"Experimental" Setup

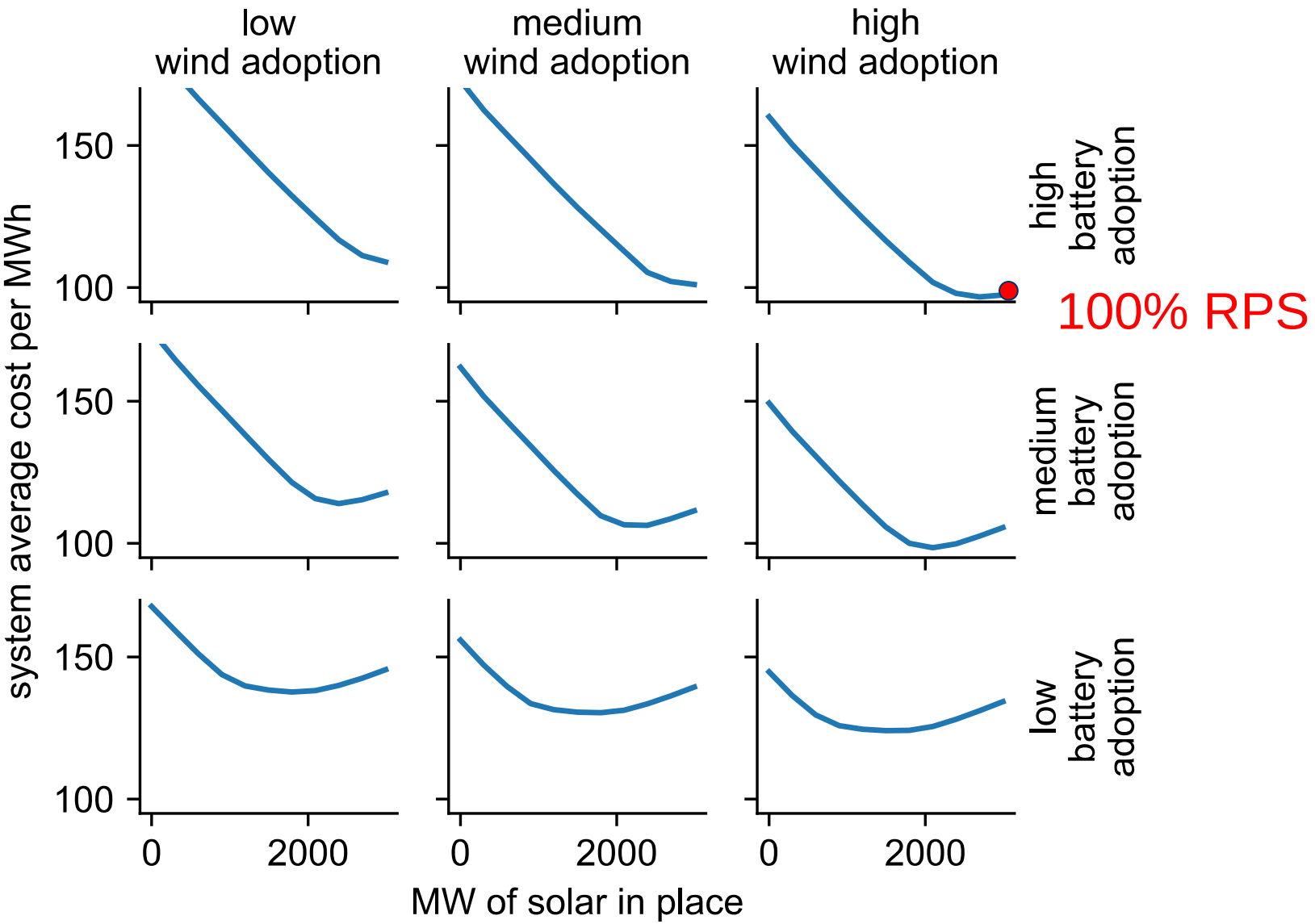
- Use open-source Switch capacity optimization software
  - Leading-edge tool for integrated planning with renewables, storage, demand response, etc.
  - http://www.switch-model.org
- Toy model of Oahu
  - 2045 costs from NREL, EIA
  - Greenfield power system
  - Allow arbitrarily small increments of thermal capacity
  - Historical hourly load shapes and weather from 2007–08
  - Optimized for 13 sample days representing the range of weather conditions
- Evaluate incremental capacity value of solar and average cost of power for all permutations of
  - High, med, low wind (0%, 50%, 100% of amount used for 100% RPS)
  - High, med, low batteries (0%, 50%, 100% of amount used for 100% RPS)
  - Solar in 10% steps from amount 0 to amount used for 100% RPS

Results: Capacity Value of Solar



- As solar penetration increases, capacity value drops
- At low levels, more wind can reduce capacity value of solar
- With batteries, capacity value of solar becomes more stable (albeit low)

Results: Capacity Value of Solar



- There is a "sweet spot" for solar adoption
- With less wind (left vs right), more solar is better
- With more batteries (top vs bottom), more solar is better
- Need optimization tools to choose the right portfolio
  - Not evident from capacity value

Conclusions

- Planners must consider the full timeseries of renewables, loads and storage operation
- Requires next-generation models
- Fits naturally with integrated resource planning in regulated utilities
- May need new techniques to do this in market regions
  - Can capacity markets be updated to consider full timeseries behavior?
    - E.g., use weather-dependent bids and a full commitment/dispatch model
  - Can efficient portfolios be achieved via bilateral contracting?