
Photo: S. Rose

Compensating for Wind Variability Using Co-located Natural Gas Generation and Energy Storage

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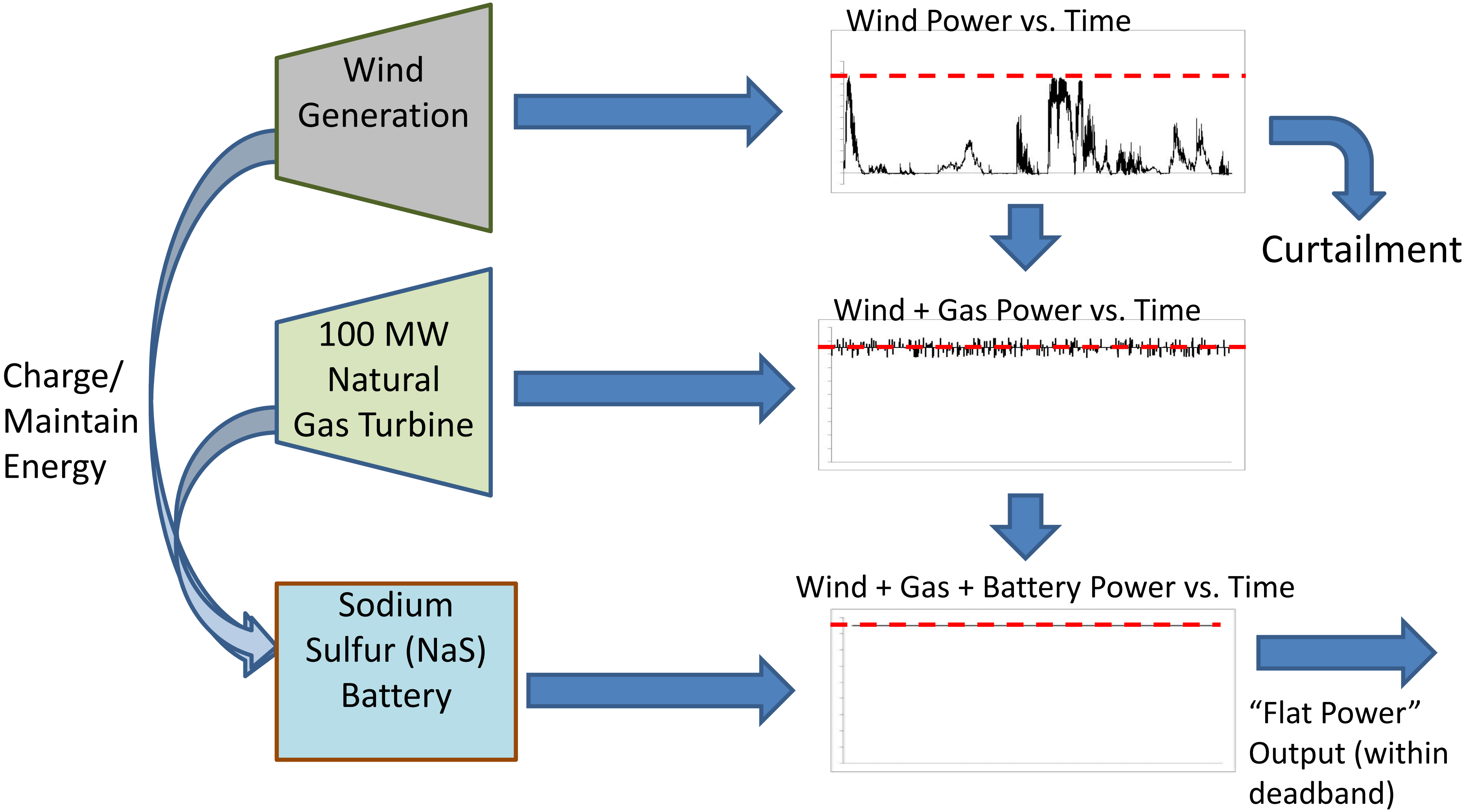
- Operation of co-located systems
- Costs of co-located systems
- Wind integration costs for co-located systems

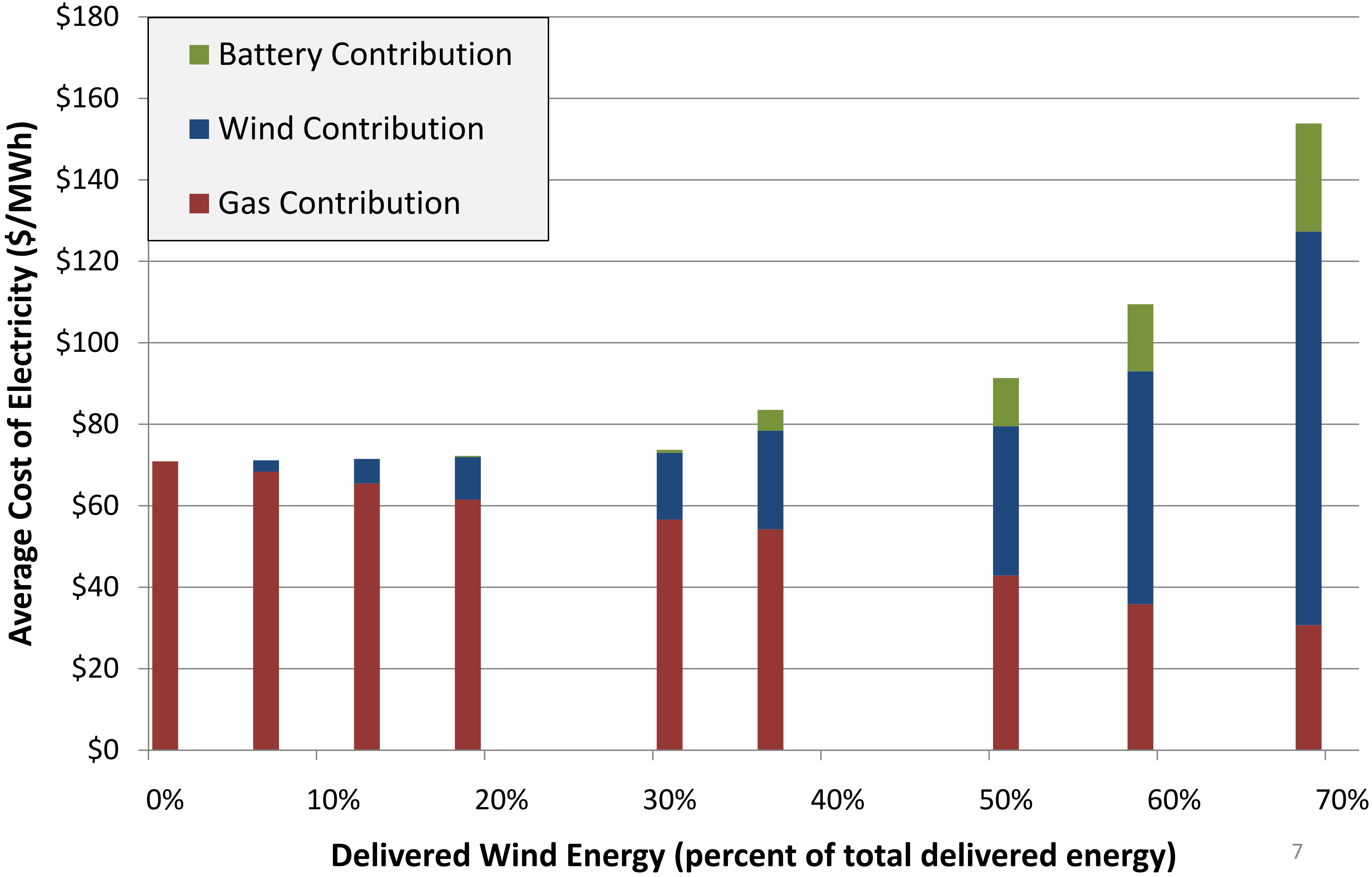
Wind integration is well-studied but nuanced

Issue	***Implemented Solution***
One hour blocks may be inappropriate	**This study has a 10 sec time resolution**
Using a single compensating technology may be inefficient	**This study uses a hybrid system for fill-in power**

A Co-located wind/natural gas turbine/energy storage system can deliver "Baseload" power



Average Cost of Electricity is relatively constant over a wide range of wind penetrations for the Wind/Gas/NaS Battery Systems



As wind penetration increases, costs stay flat and battery sizes are reasonable

Wind Nameplate Capacity (MW)*	0	25	43	67	150
Delivered Wind Energy	0%	12%	19%	30%	50%
Average Cost of Electricity ($/MWh)	71	71	72	74	91
Contribution of NaS Battery to Average Cost of Electricity (percent)	0%	0%	0.5%	1%	13%
NaS Battery Capacity (MWh)	0	0	10	21	250

* System Target Power Output is 100 MW

Wind integration costs are comparable with estimates for system-wide integration

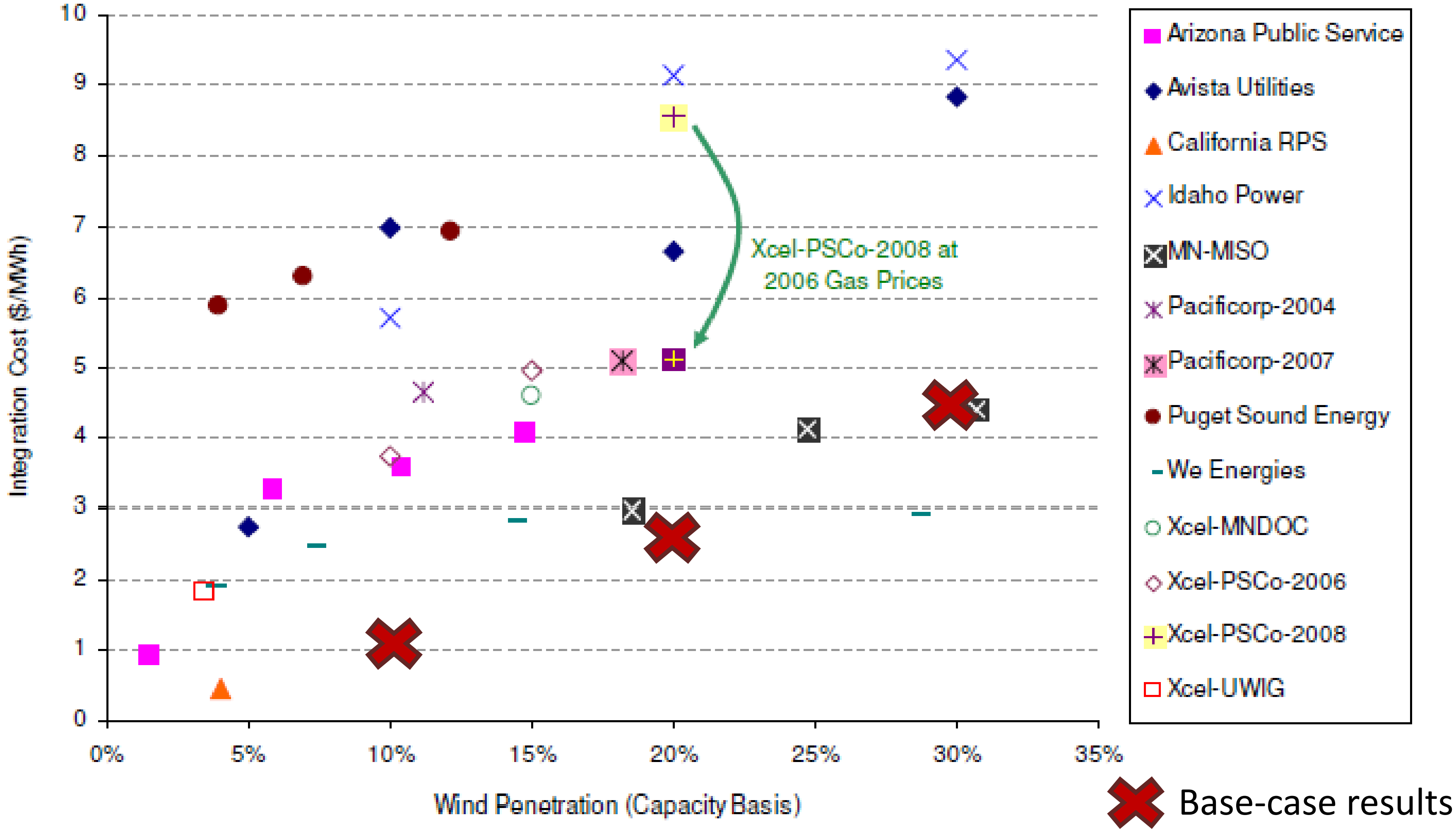


Figure from: Wiser, R., & Bolinger, M. (2008). *2008 Wind Technologies Market Report.* US DOE.

Policy Implications

- Renewable Portfolio Standard levels of wind can be locally smoothed at a reasonable cost ***if***
  - Remaining generation is chosen appropriately
  - A small amount of fast-ramping energy storage is used
- These systems are much simpler than other options and may be a better proposition for some applications
- Applicability of these systems is dependent on electrical system structure
- Strategies like this will only be implemented if wind generators are motivated to reduce variability

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Questions!