Storage End Effects
An evaluation of common storage modelling assumptions

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Background/Motivation

How to deal with storage at end of model period has received little attention in the literature:

- Some studies require refilling of storage
- Many run a longer model period and cut off the end effects
- One study applied a value for stored energy at end of period using “heuristic based on operator experience” (Castronuovo and Usaola 2013)

No study has looked at how to value storage at the end of a model period and how different methods impact the model results.

Methods

21.2 GW of wind
One week
10 minute resolution
Simplified storage model

Methods compared:
- Refilling (baseline)
- 28 X 6 hours with stored energy valued
- 168 X 1 hours with stored energy valued
- 28 X 6 hours with six hour look ahead
- 14 X 12 hours with twelve hour look ahead

Rainflow counting used to compare storage operation
28 X 6 Stored Energy Value

- Dashed line is one week with refilling (baseline)

$50/MWh  

$158/MWh  

$1000/MWh

21.2 GW Wind  
14 GWh Storage  
Week in middle of year
168 X 1 Stored Energy Value • Dashed line is one week with refilling (baseline)

$50/MWh

$158/MWh

$1000/MWh

21.2 GW Wind
14 GWh Storage
Week in middle of year
Look Ahead Stored Energy

- Dashed line is one week with refilling (baseline)

Six Hour

Twelve Hour

21.2 GW Wind
14 GWh Storage
Week in middle of year
Characterizing Storage Operation

→ Rainflow Counting
→ Common method for characterizing storage cycling
→ Counts number of cycles (and partial cycles)

By Cutler at English Wikipedia [Public domain], via Wikimedia Commons
Look Ahead Cycle (Rainflow) Counts

21.2 GW Wind
14 GWh Storage
Week at start of year
28 X 6 Storage Cycle (Rainflow) Counts

21.2 GW Wind
14 GWh Storage
Week at start of year
21.2 GW Wind
14 GWh Storage
Week in middle of year
Conclusions

Valuing storage appears to provide an alternate to modelling longer periods and discarding the ends.

The value of the stored energy depends on the model structure – need to investigate this more.

Different choices of storage model structure has a significant impact on model results and should not be taken lightly.
Questions/Discussion?

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