BSM Repowering – Market Analysis

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Agenda

- Introduction
- Methodology
  - Overview
  - Price Simulation
  - Real Option Valuation (ROV)
- Results
- Conclusions & Future Work
  - Conclusions
  - Future Work
- Questions/Feedbacks

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Introduction

Introduction

- **One of the concerns of a potential repowering exemption is that it may carry additional risk of causing uneconomic units to remain in the market and repower, and therefore artificially suppress capacity prices**
  - If a plant is “uneconomic”, it should be retiring rather than given a “free pass” to repower.
  - How to determine what constitutes “uneconomic” is discussed on the following slides.

Introduction cont'd

- Traditional Net Present Value (NPV) methodology had suggested continued pressure for steam turbines to retire in downstate areas. (2017 State of the Market Report)
- However, the units that would be expected to be retired when using an NPV analysis continue to operate even though the Zone J capacity market is long.
- That result indicates that there might be a different analysis that better reflects when a unit is uneconomic and at what point it should retire.
- A different analysis is described on the following slides.
- The objective of this ongoing analysis is to develop a framework to:
  - Better understand the economic decision to retire or continue operation.
    - The analysis described in this presentation is not looking at subsidies which also could effect the economic decision.
  - Develop insights on the sustained excess capacity level in Zone J maintained by the continued operation of uneconomic units.
  - Evaluate the options for potential BSM Rules to examine and exempt repowerings.

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Methodology

Overview

- Traditional NPV methodology assumes the retirement decision is made “now or never”, and therefore fails to consider the value of option or flexibility to retire at a later time.

- Real option valuation (ROV) overcomes this short-coming by taking into account optimal retirement timing in the evaluation, therefore this analysis is more like to represent the result of more robust decision-making.
  - The NYISO acknowledges that the actual decision might incorporate the cost and value of a “replacement” or “refurbishment” of the unit. However, for purposes of this analysis it is looking at a series of binary decisions to retire or not retire over time.

- ROV has been applied to many types of problems, including options to invest, expand, contract, or abandon.

Overview cont'd

Simulate stochastic prices in the future.

At each decision point, estimate the expected value of continuing operation by linear regression.

At each decision point, compare the value of retirement to that of continuation, and make a decision to either retire or continue operation.

Making assumptions at the end of a unit's like, and then looking backward to evaluate the economics of the plant at the initial uneconomic/retirement decision point.

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Price Simulation

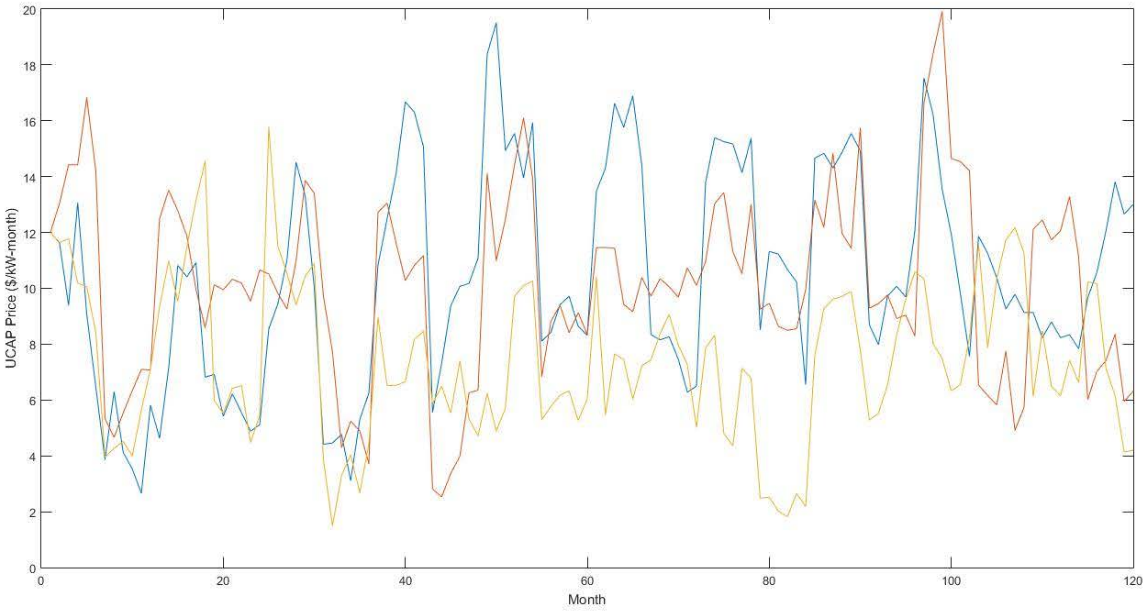
- Summer and Winter UCAP prices are simulated using mean-reverting processes:

$$dS_t = \kappa(\alpha - S_t)dt + \sigma\sqrt{dt}\varepsilon$$

S_t – UCAP price at time t
κ – Speed of reversion
α – Long-run mean of UCAP prices
σ – Diffusion term of the process
dt – Time step
ε – Random variable from standard normal distribution

Price Simulation cont'd

- Parameters were estimated using spot auction prices from May 2003 to April 2018.
- Three (out of 10,000) simulated sample paths are shown below:



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Real Option Valuation (ROV)

- **At any time t, a power plant has the option to choose between retirement or continuing operation:**
  - Retirement: receive a scrap value V_{scrap}
  - Continuing operation: receive a profit $\pi(S_t)$, and preserve the expected value of the plant

- **The value of the plant at time t is therefore:**

$$V_t(S_t) = \max\{V_{scrap}, \pi(S_t)dt + E_t[V_{t+1}(S_{t+1})|S_t]\}$$

V_t – Value of the plant at time t
S_t – UCAP price at time t
V_{scrap} – Scrap value of the plant
$\pi(S_t)$ – Profit at time t (UCAP price + E&AS – Variable Cost – Fixed Cost – Capital Expenditure)
dt – Time step

Real Option Valuation (ROV) cont'd

- At time t, the expected value of the plant at time $t+1$ can be obtained from the current UCAP prices:

$$E_t[V_{t+1}(S_{t+1})|S_t] = a + bS_t + cS_t^2$$

where a, b, c are obtained by regressing the discounted value of plant at time $t+1$ on the UCAP prices at time t (Longstaff and Schwartz (2001)).

- Assume the ending value is known (equal to the scrap value), the value of the plant at the start of evaluation can be solved backward-looking:

$$V_t(S_t) = \max\{V_{scrap}, \pi(S_t)dt + E_t[V_{t+1}(S_{t+1})|S_t]\}$$

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Results

Results

- Table below lists the parameters used in this analysis:

		Summer	Winter
α	Long-run mean of UCAP prices ($/kW-month)	11.83	5.165
κ	Speed of reversion	0.075	0.068
σ	Diffusion term of the process	1.847	1.295
r	Discount rate (annual)	9.6%	
T	Remaining lifetime (year)	10	
V_{scrap}	Scrap value ($/kW)	0	
GFC	Going Forward Cost ($/kW-month)	10	

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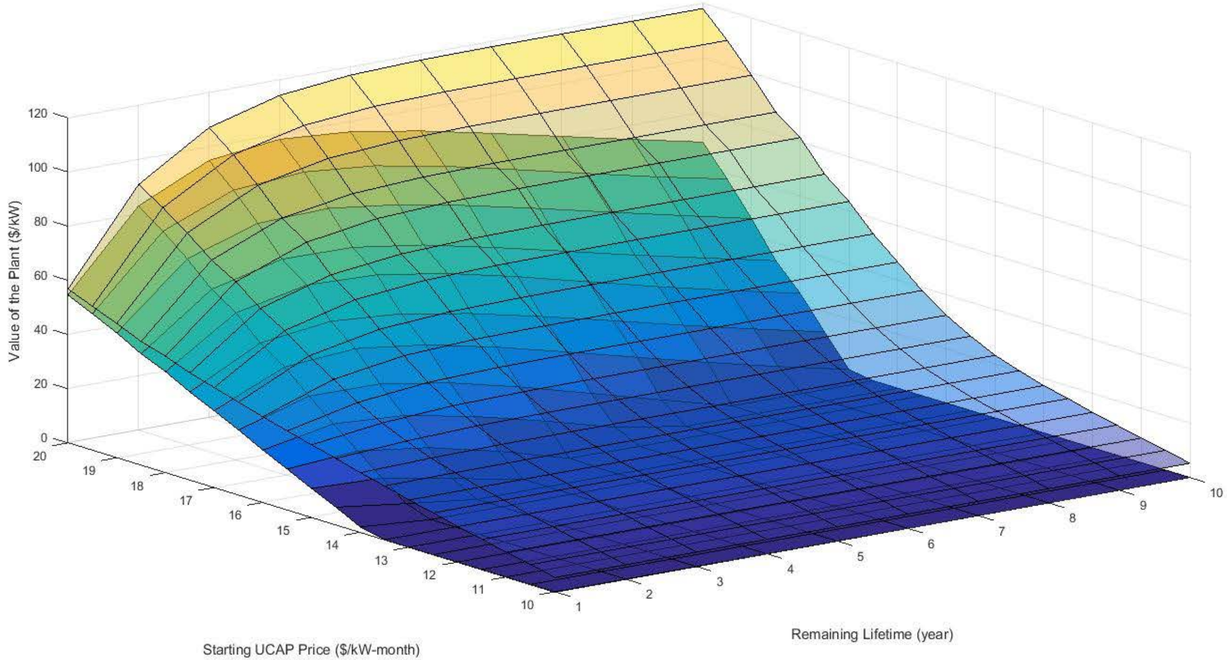
Results

- Value of plant under ROV (top layer) and NPV (bottom layer) vs. initial UCAP prices and remaining lifetime



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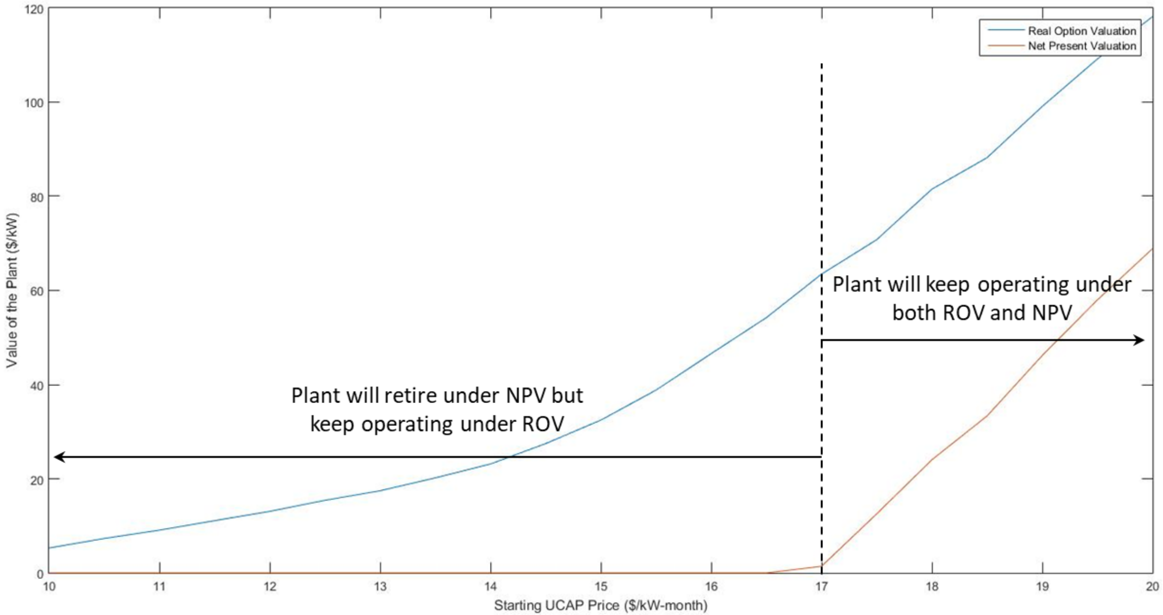
Results cont'd

- Value of plant under ROV (blue) and NPV (red) vs. initial UCAP prices (remaining lifetime = 10 years)
- For our hypothetical plant, when the initial UCAP price is below 17 $/kW-month, NPV recommends the plant to retire, while ROV recommends the plant to stay.



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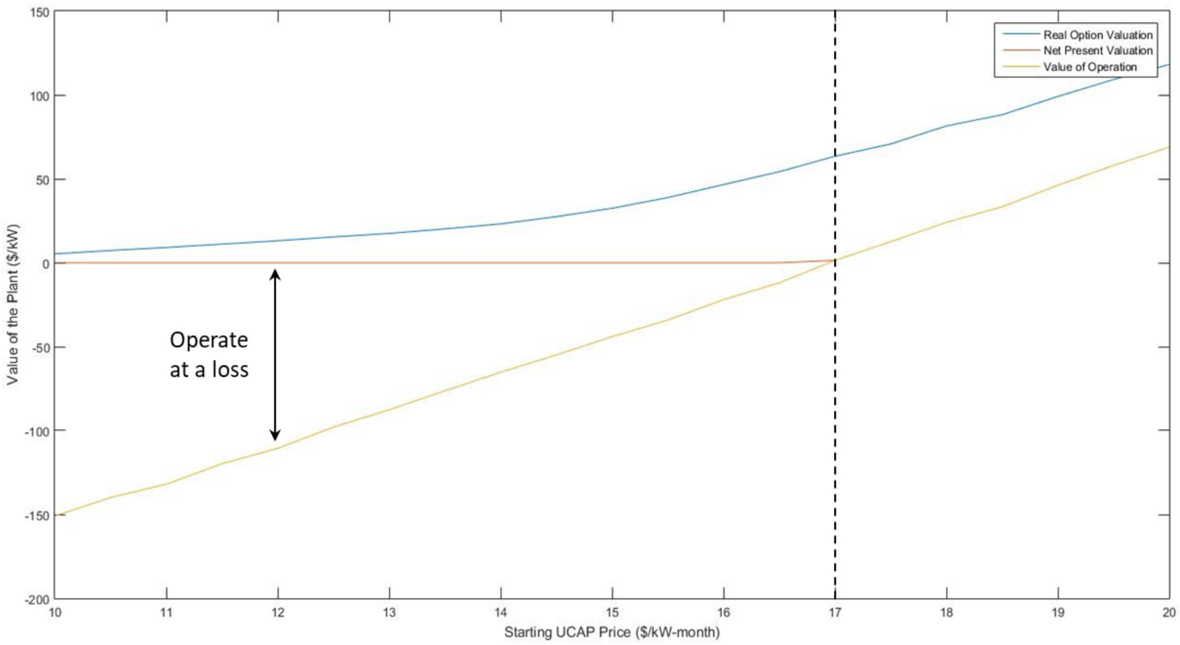
Results cont'd

- Value of plant under ROV (blue), NPV (red) and Operating (yellow) vs. initial UCAP prices (remaining lifetime = 10 years)
- Not considering the option of optimal retirement may result in biased claim that a plant is operating uneconomically and should be retired.



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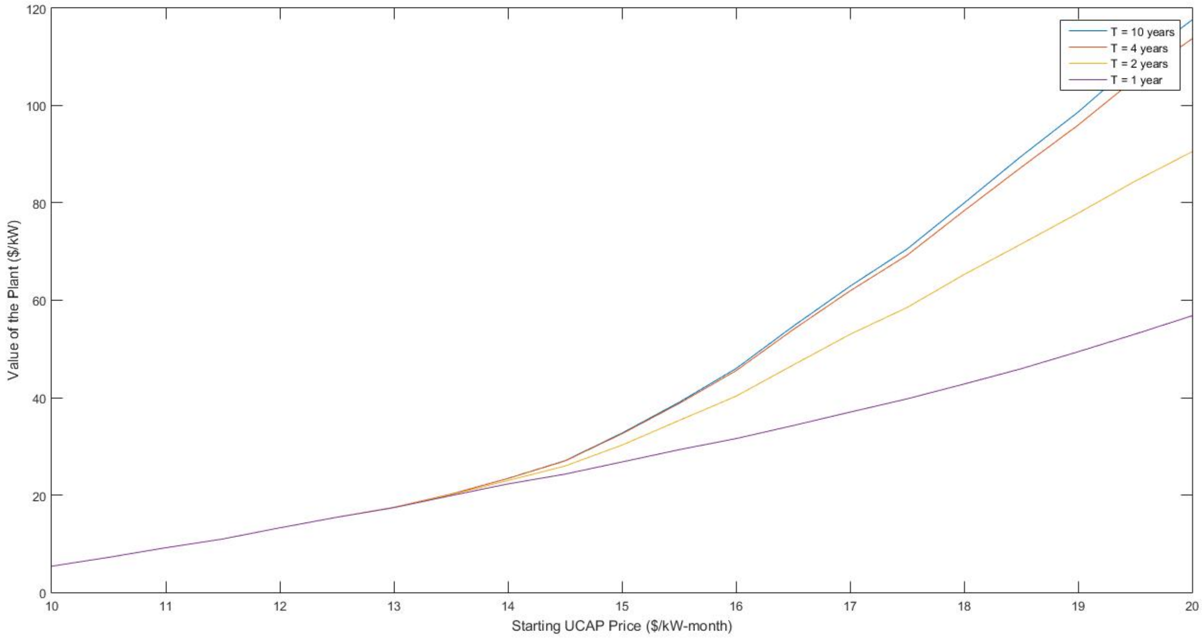
Results cont'd

- Value of plant under ROV vs. initial UCAP prices, with remaining lifetime equals to 10 years (blue), 4 years (red) and 2 years (yellow) and 1 year (purple).
- Marginal value of remaining lifetime is diminishing for the hypothetical plant.



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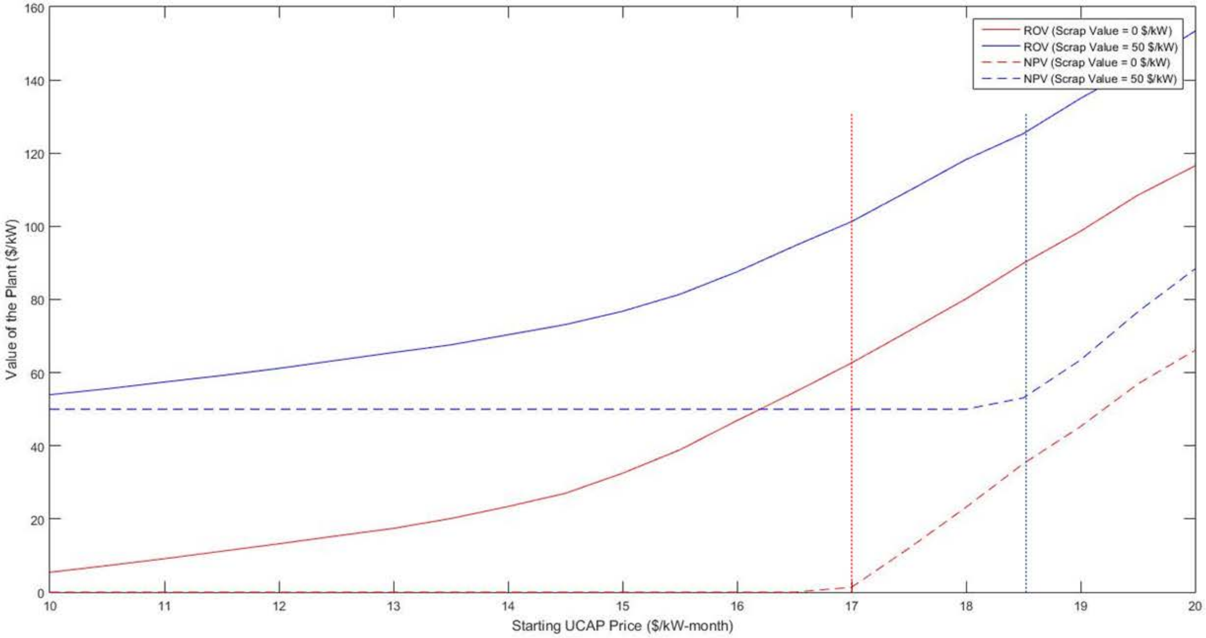
Results cont'd

- Value of plant vs. initial UCAP prices. Dashed lines represent values under NPV, solid lines represent values under ROV; Blue lines represent scrap value of 50 $/kW, red lines represent scrap value of 0 $/kW (remaining lifetime = 10 years)
- Retirement decisions under ROV are more robust to the scrap values compared to NPV.



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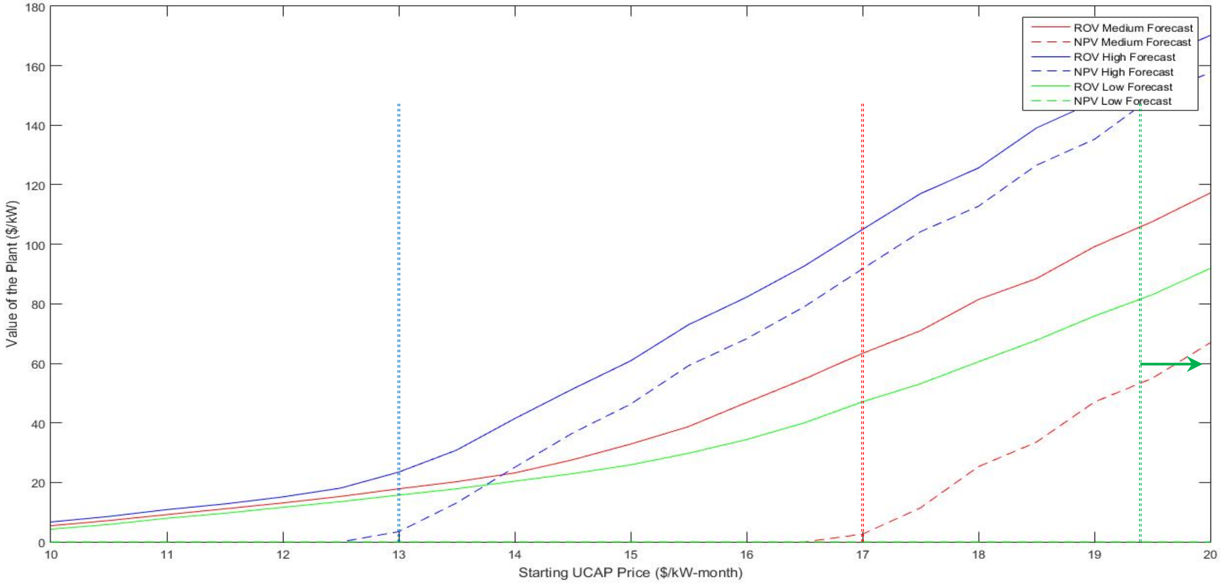
Results cont’d

- Value of plant vs. initial UCAP prices. Dashed lines represent values under NPV, solid lines represent values under ROV; Red lines represent medium long-run UCAP price forecast, blue and green lines represent +/- 20% of medium long-run forecast, respectively
- Retirement decisions under ROV are more robust to the long-run forecast compared to NPV.



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Conclusions & Future Work

Conclusions

- Simulation results show that the value of option to retire at a later time can be substantial and may contribute to a plant with negative NPV to keep operating.
- Other factors that may result in the retention of plant with negative NPV are: opportunity to mothball, significant value of point of interconnection, waiting for upward future prices following the retirement of other plants, etc.

Future Work

- Extend the framework to include the option to repower, and evaluate the conditions under which repowering may be the optimal strategy.
- Explore the need of modeling uncertainties other than the UCAP prices.
- Investigate alternatives to calibrate simulation parameters.
- Evaluate the Demand Curve peaking unit for each MCZ under ROV.
- Incorporate potential portfolio effects under ROV.

Questions?

Feedback?

- Email additional feedback to: nguo@nyiso.com and deckels@nyiso.com

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