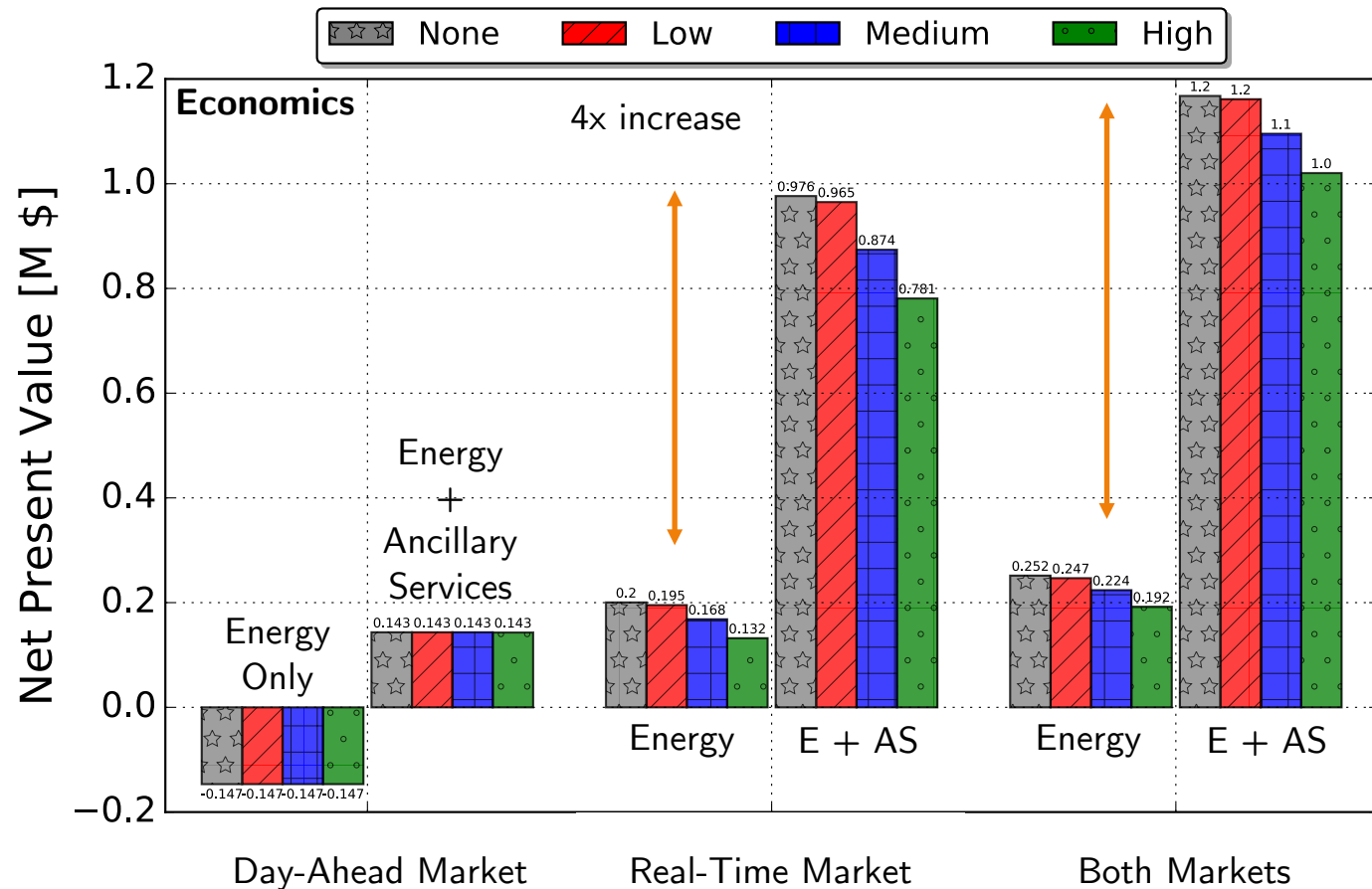


Degradation Effects for Sodium Sulfur Batteries



Consider 5-year replacement strategy

Degradation Case	Cycles to Failure
None	∞
Low	40,000
Medium	4,000
High	400



Key Findings

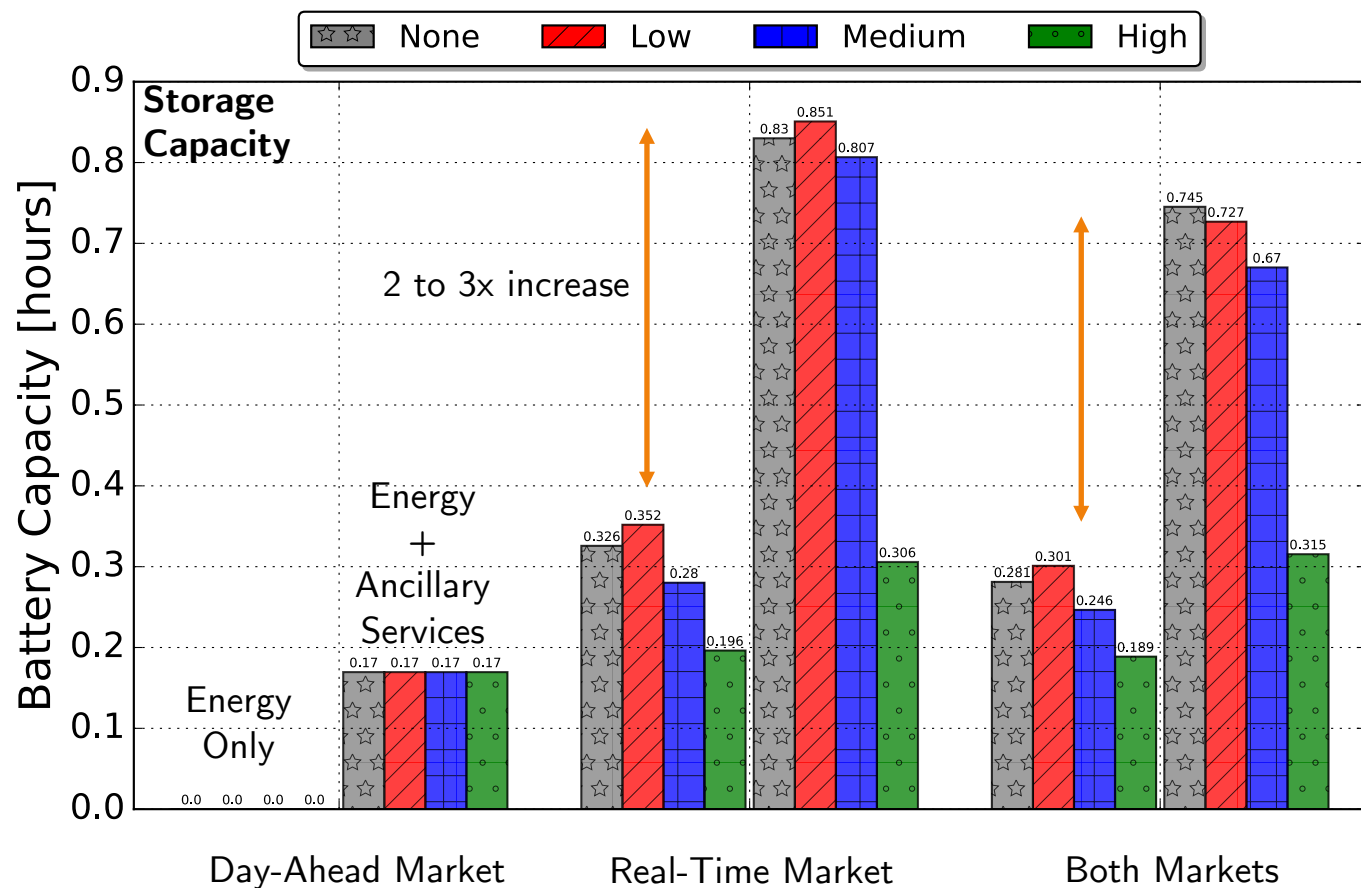
- **AS and RTM** drive economics
- Only **10% NPV improvement** from *technology breakthrough*
- **NPV** is most sensitive to **market participation mode**

Degradation Effects for Sodium Sulfur Batteries



Consider 5-year replacement strategy

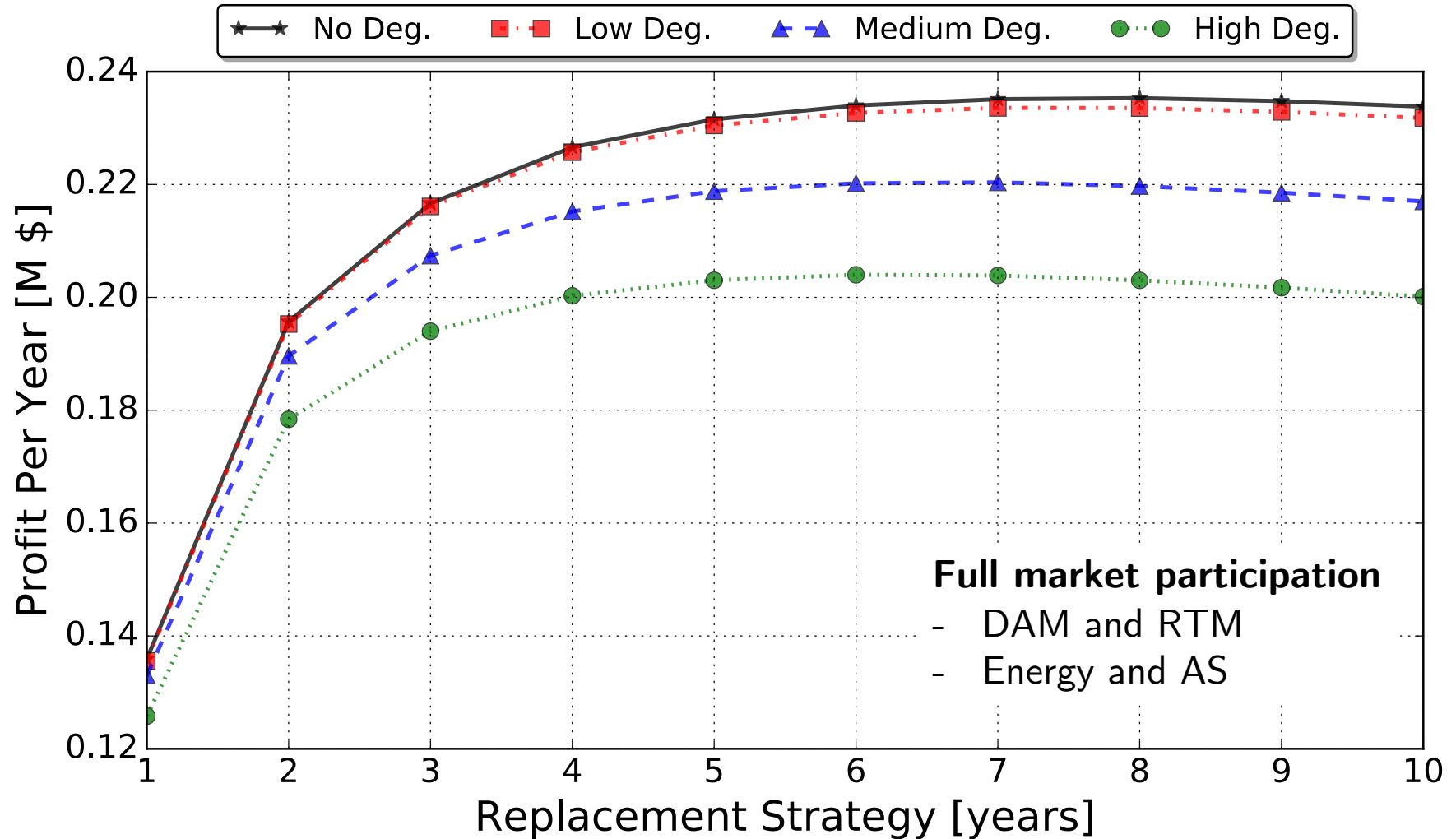
Degradation Case	Cycles to Failure
None	∞
Low	40,000
Medium	4,000
High	400



Observations

- Need larger battery for AS, RTM
- Low degradation (red): largest battery
- High degradation (green): 10% lower NPV, **2x smaller battery**
- All cases: **less than 1 hour of storage** is optimal

When to Replace?



Observations:

- Replace current technology ([med. case](#)) after 6 to 8 years
- 10x slower degradation → increased profits of 20,000 \$ / MW / yr

Concentrated Solar Power Technologies



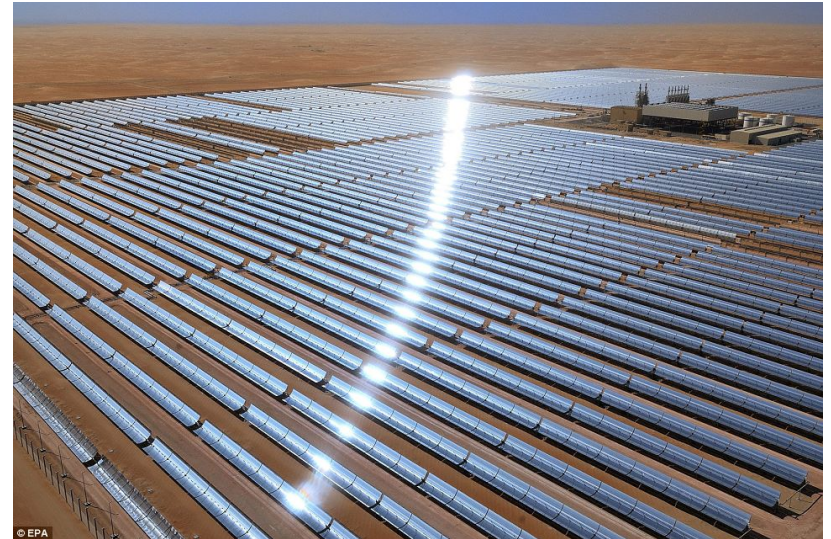
Power Tower



Ivanpah Solar, California

- Cost: \$2.2 billion
- 1,100 GWh / year (100,000 U.S. homes)
- Direct steam generation (1050 °F)
- Land use: 14 km²
- No Storage

Parabolic Trough



Shams I, United Arab Emirates

- Cost: \$600 million
- 210 GWh / year (20,000 U.S. homes)
- Organic heat transfer fluid (400 °F)
- Land use: 2.5 km²
- No Storage

National Mall: 0.6 km²

Day-Ahead Energy Prices and Solar Irradiance

