

Bill Savings, Market Revenues, and More: Unlocking the Stacked Value of Storage Assets

Integrating battery storage into energy projects provides great benefits...

- Maximize self-consumption from solar and provide peak shaving capabilities
- Tap into valuable revenue streams for dispatchable resources (capacity markets, demand response, and more)
- Provide resiliency solutions and microgrid capabilities to businesses

...but optimizing a dispatch strategy is challenging.

A battery operator needs to have:

- Intelligent software to evaluate the value and opportunity cost of different battery applications
- Extensive market expertise and experience dispatching assets into wholesale energy programs
- A deep understanding of customer objectives and constraints to customize the best solution for them

Value stacking is complex, but crucial for project economics. We designed DER.OS around these challenges.

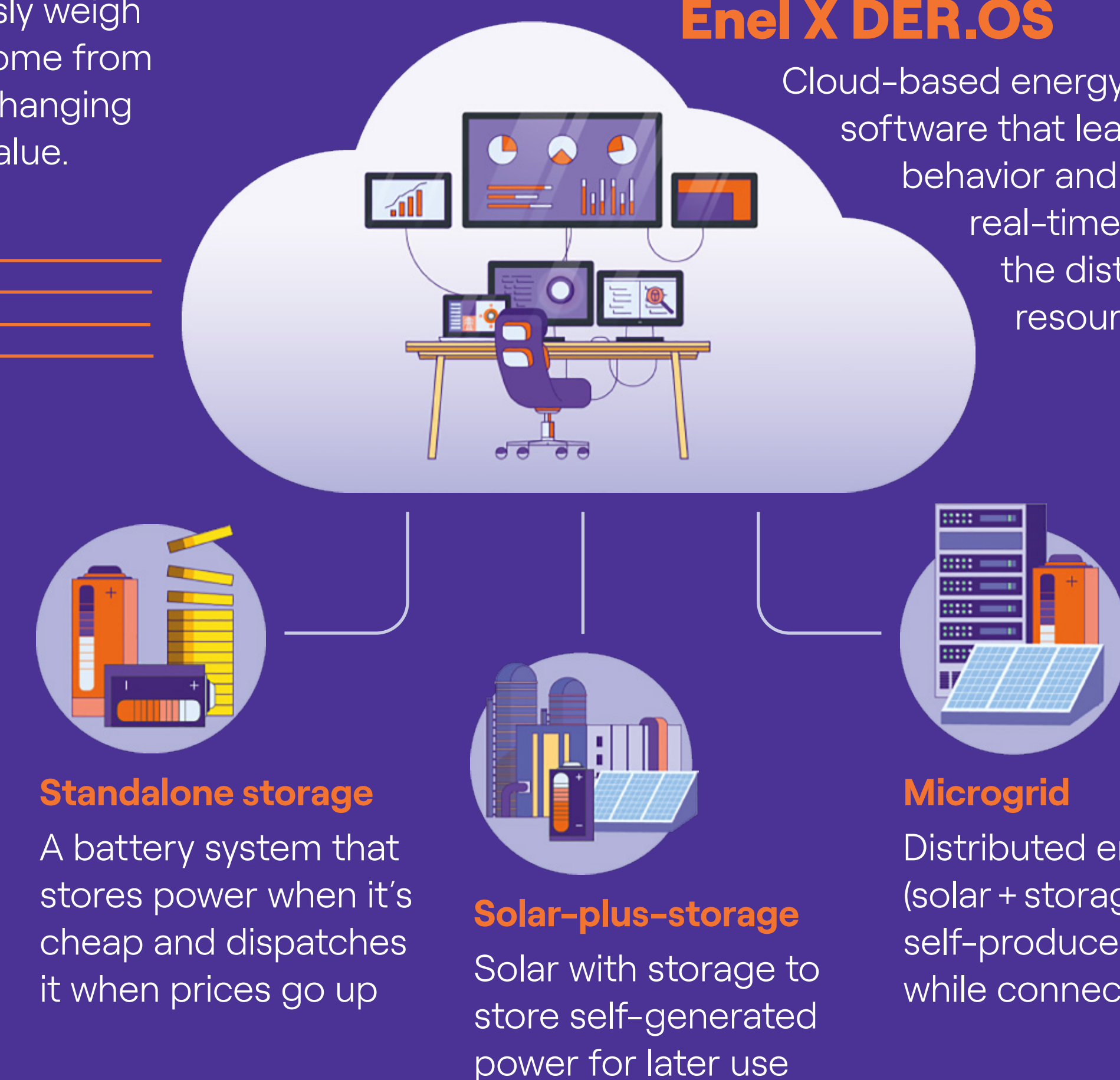
An effective battery optimization algorithm needs to continuously weigh the benefits of various revenue streams. These value streams come from different sources and are contingent on a multitude of rapidly changing factors, making optimization software essential to maximizing value.

Value Streams and Sources:

- Utilities/Retailers**
 - Bill Savings**: Storage can reduce bills through Demand Charge Management and Energy Arbitrage.
 - Demand Response**: Utility programs provide a contracted revenue stream for curtailing energy usage.
- Grid Operators (e.g., ISOs/RTOs)**
 - Coincident Peak Reduction**: Grid operators sometimes levy a "hidden" demand charge, based on their demand during coincident peak hours.
- State/Federal Agencies**
 - Upfront Capex Reductions**: State and federal incentives exist to modernize and stabilize regional grids.

Enel X DER.OS

Cloud-based energy management software that learns the facility's behavior and optimizes real-time performance of the distributed energy resources (DERs)



Standalone storage
A battery system that stores power when it's cheap and dispatches it when prices go up

Solar-plus-storage
Solar with storage to store self-generated power for later use

Microgrid
Distributed energy system (solar + storage + genset) to self-produce energy on site while connected to the grid

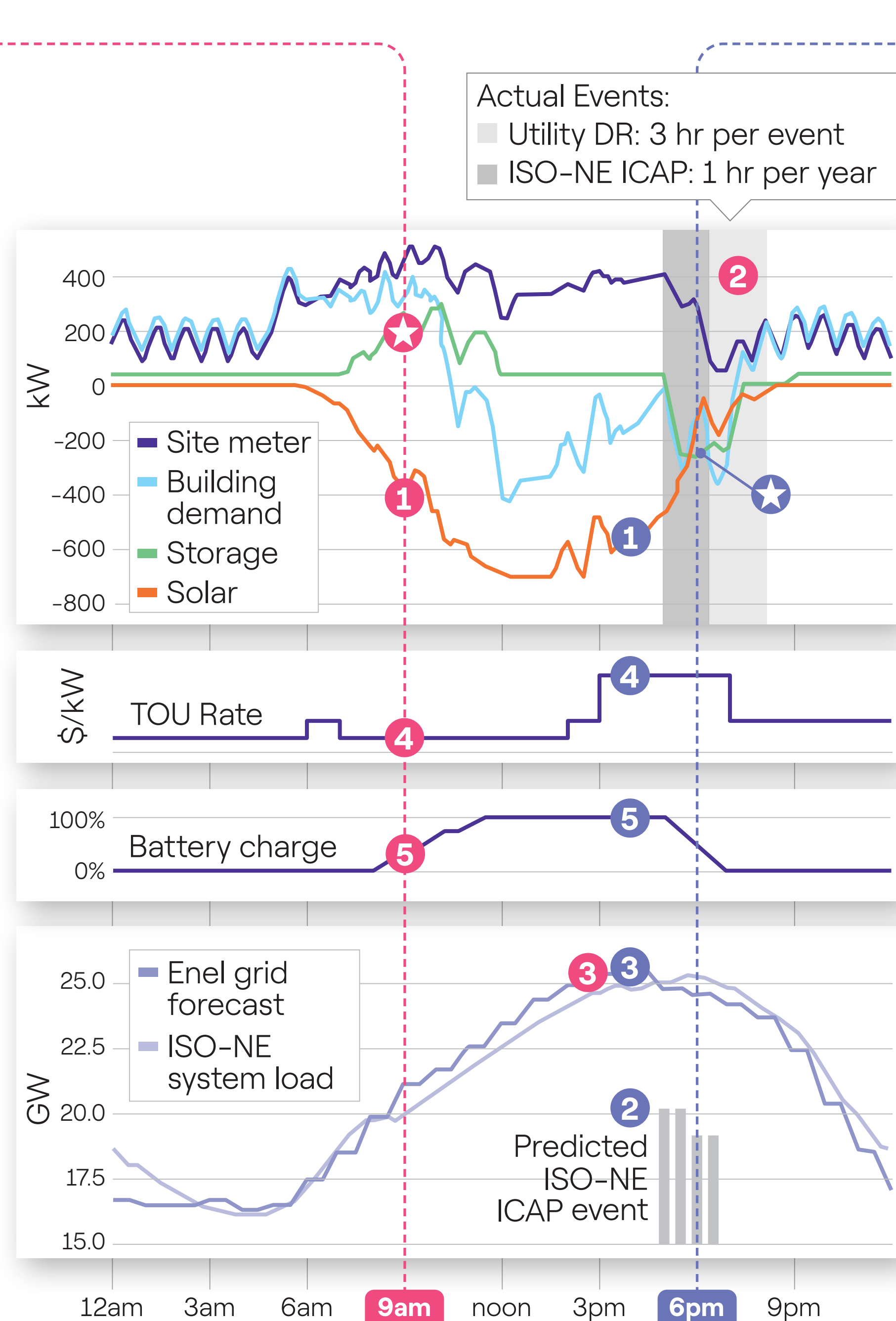
A case study of battery optimization for a campus in Massachusetts

9:00 AM

- Power from grid: 460 kW
- Solar output: 400 kW
- Battery charging: 260 kW

How DER.OS optimizes during a summer **morning**

- Solar is producing, and our weather forecast suggests all-day sun
 - DER.OS knows there will be a utility DR event in the evening
 - In addition, we predict grid peak will be at ~4-5pm, with high likelihood of an ICAP event
 - Current \$/kWh energy (TOU rate) is low
 - Battery is at ~20% charge
- ★ DER.OS charges battery from solar to prepare for DR event, ICAP event, and peak \$/kWh rate in the afternoon/evening



6:00 PM - DR Event

- Export to grid: 284 kW
- Solar output: 140 kW
- Battery discharging: 260 kW

How DER.OS optimizes during a summer **afternoon**

- Solar production is decreasing
 - DER.OS predicts ICAP event will occur between 4-6pm
 - Dispatch should hit both ICAP and DR event
 - Current \$/kWh energy is high
 - Battery is at 100% charge at 4pm
- ★ DER.OS will dispatch battery at full capacity for 2 hours, starting 30 minutes before ICAP event prediction, for optimal chance of reducing load at peak hour while also hitting DR event

Optimized battery dispatch reveals notable financial benefit of solar+storage

Upfront cost of battery energy storage system

Pricing summary	
Energy Storage System	\$1,205,000
Engineering	\$18,000
Installation and Balance of System	\$365,000
Total Project Price	\$1,588,000
Incentives Available	
Investment Tax Credit	30% of Capital Expenses
Massachusetts SMART Storage Incentive Adder	\$0.03-\$0.05 per kWh of solar

...enables significant cash flows across many revenue streams...

Customer Cash Flow	Total	Year 1	Year 2	Year 3	Year 20
Savings					
Electricity Bill Savings	\$411,000	\$16,800	\$17,000	\$17,200	\$24,800
Coincident Peak Event	\$1,759,200	\$35,200	\$49,600	\$140,000	
Program Revenues					
DR Forecast	\$1,608,800	\$108,200	\$111,200	\$114,400	\$99,400
Incentives					
Smart Storage Adder	\$728,000	\$38,200	\$38,000	\$37,800	\$34,600
Operating Expenses					
Battery Management Services	(\$476,800)	(\$17,400)	(\$19,800)	(\$20,200)	\$29,200

...and reveals example payback period

Economics	
Total project revenues	\$4.04M
Net project price after incentives	\$1.1M
Simple payback time	5-6 years