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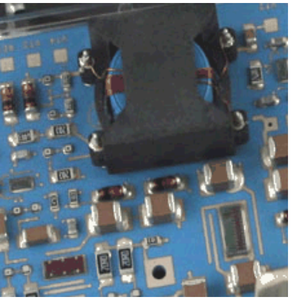

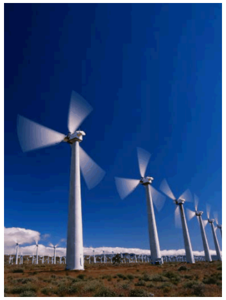

Valuing Electricity Storage with Production Cost Modeling

Jim Ellison

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Sandia National Laboratories

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Value of Storage to the Grid

- What is the value of storage to the grid?
  - One definition: the present value of the stream of benefits from a project, minus the capital and maintenance costs (NPV to the grid)
    - Where the stream of benefits are simply the savings (in annual costs of generation) that accrue from having the storage resource in a grid
- This is likely different from the value a resource owner can expect to obtain from a project (project NPV)
  - A merchant storage resource in a competitive market
    - Can only monetize those benefits that are included in the market
    - Must depend on the market to differentiate based on capabilities
    - May find value diminished by price caps
- Focus here is on value to the grid

Valuing Electricity Storage

- Is difficult because the value depends on
  - The specific system the resource is planned for, including the
    - Load pattern and variability
    - Amount and variability of renewable generation
    - Characteristics of conventional units
    - Transmission system constraints
  - The application the resource is used for (time of day shifting vs. spinning reserve, for example)
  - What it is compared with (a peaker plant, for example)
  - The size of the resource (decreasing marginal utility)
- How can a value be calculated?
  - If in a market, can use historical price information to approximate
  - If in a regulated system, need a different approach

What is a Production Cost Model?

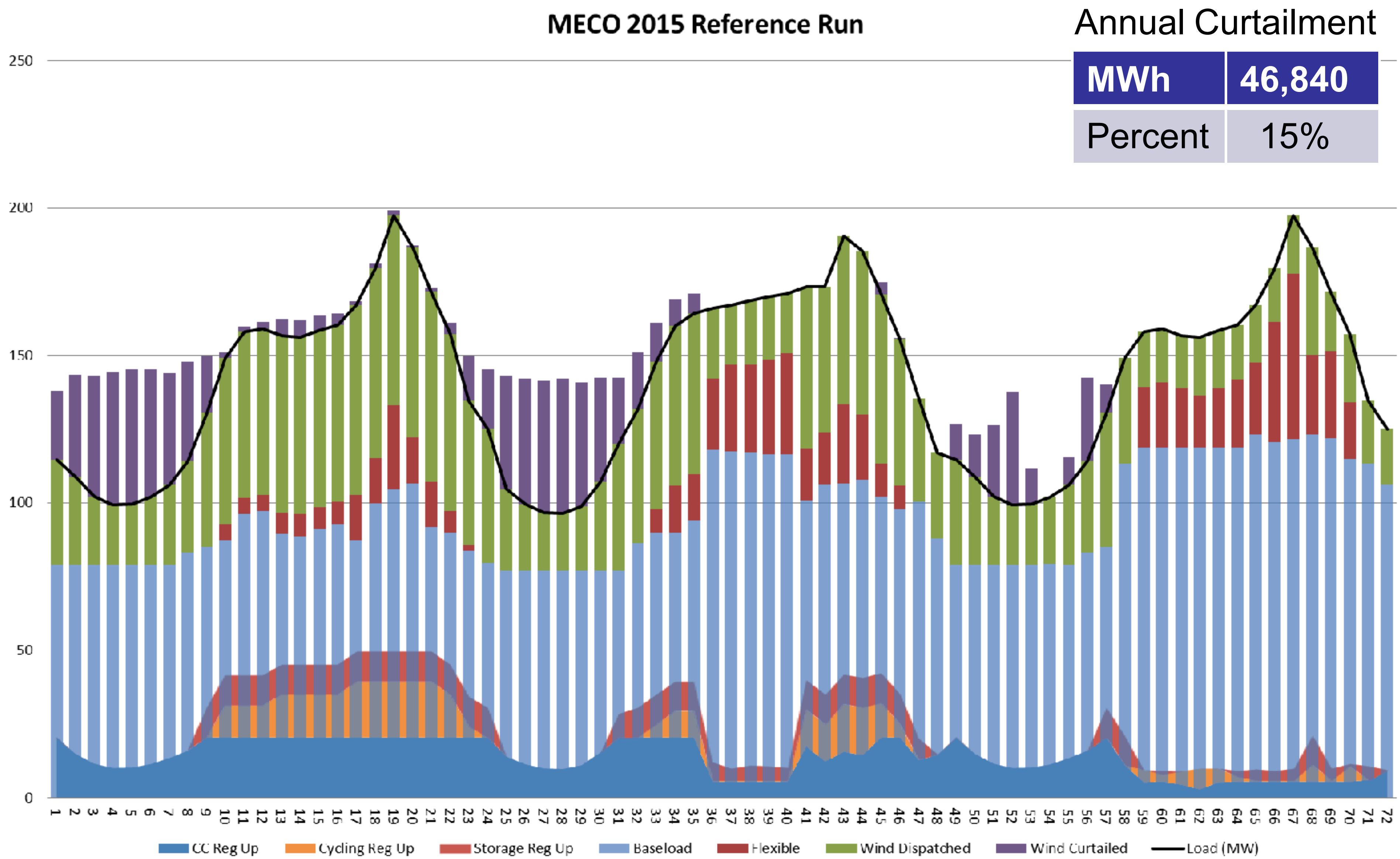
- Answers the question: What is the least-cost dispatch to meet load?
- Consists of an interface, and an optimization solver
  - Interface – allows input of unit characteristics, load data, etc.
  - Solver – a commercial solver for solving large-scale optimization problems
- If we know the generator costs, why is this so complicated?
  - Optimizing for reserves as well as energy
  - Unit commitment decision (given transmission constraints)
  - Economic dispatch (given transmission constraints)
  - Variable generation requires a variable amount of reserves

Case Study: Maui

Caveat: results presented are preliminary, and are a result of work in progress – final results may differ considerably

- 210 MW maximum load
  - 70 MW minimum
- Renewable Capacity
  - 72 MW of wind planned
  - 10 MW of biomass
- Conventional Capacity (diesel)
  - 30 MW of steam
  - 95 MW of reciprocating engines
  - 100 MW of combined-cycle

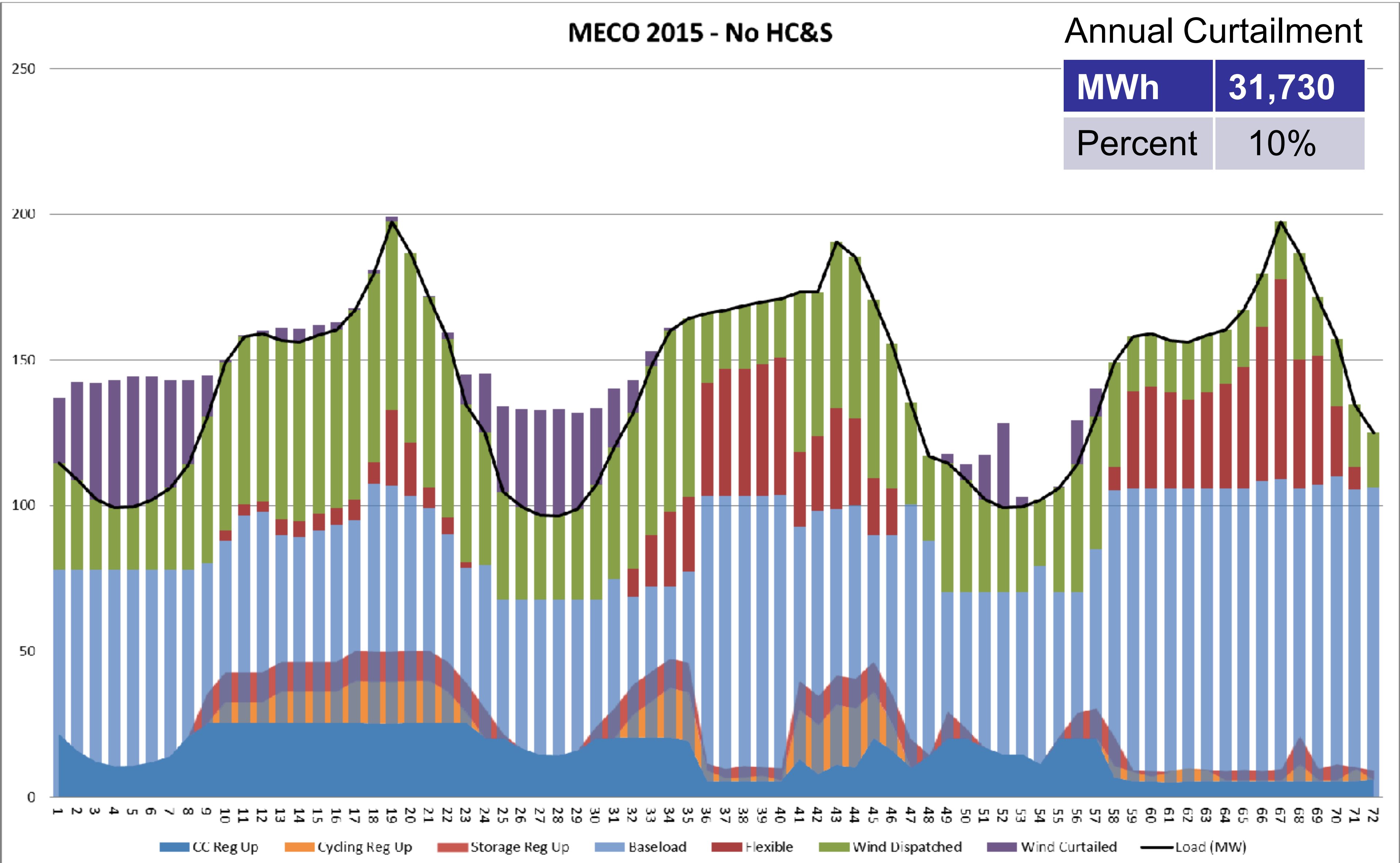
Reference Case 2015



Annual Curtailment

MWh	46,840
Percent	15%

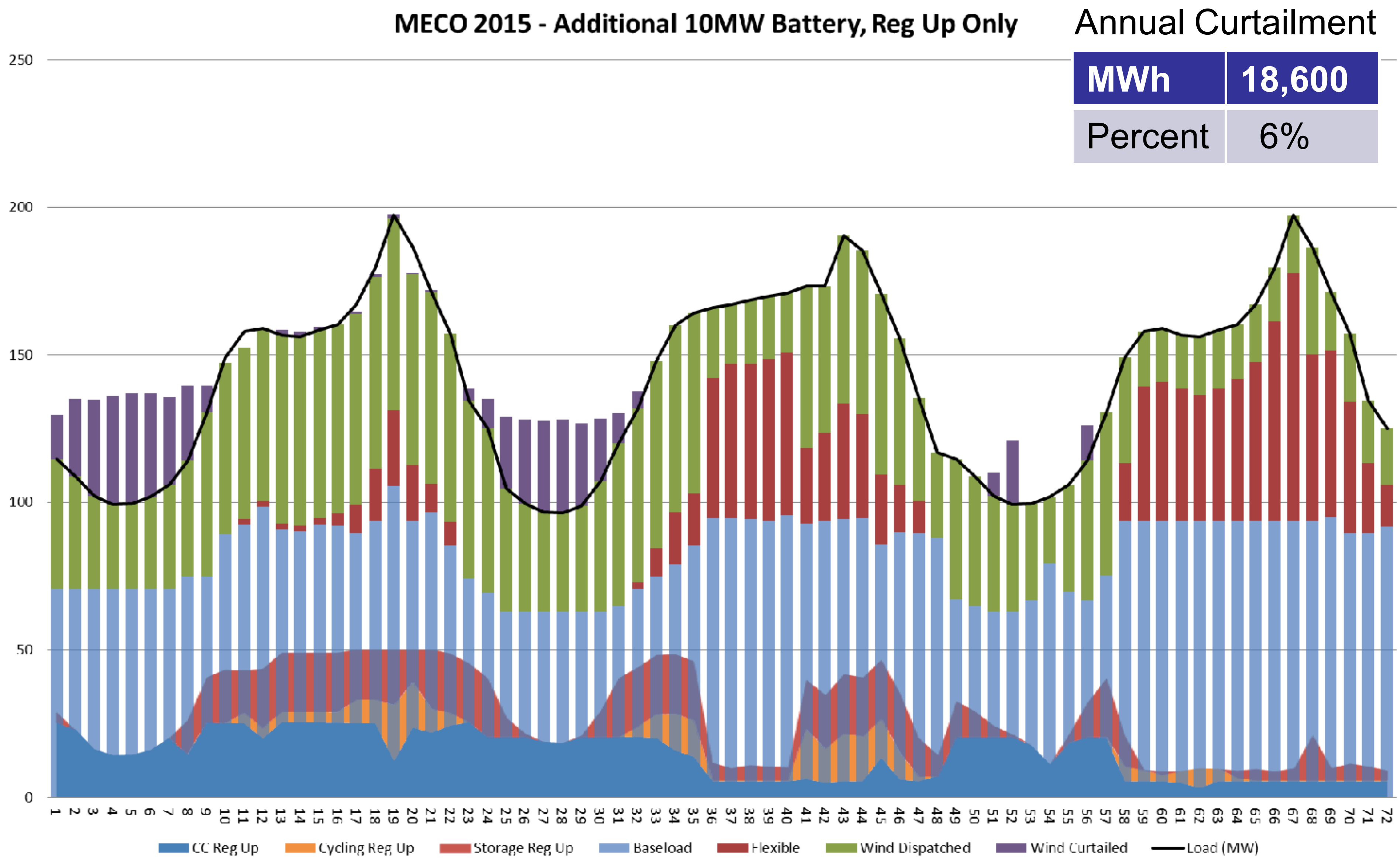
MECO 2015 – No Biomass Plant



Annual Curtailment

MWh	31,730
Percent	10%

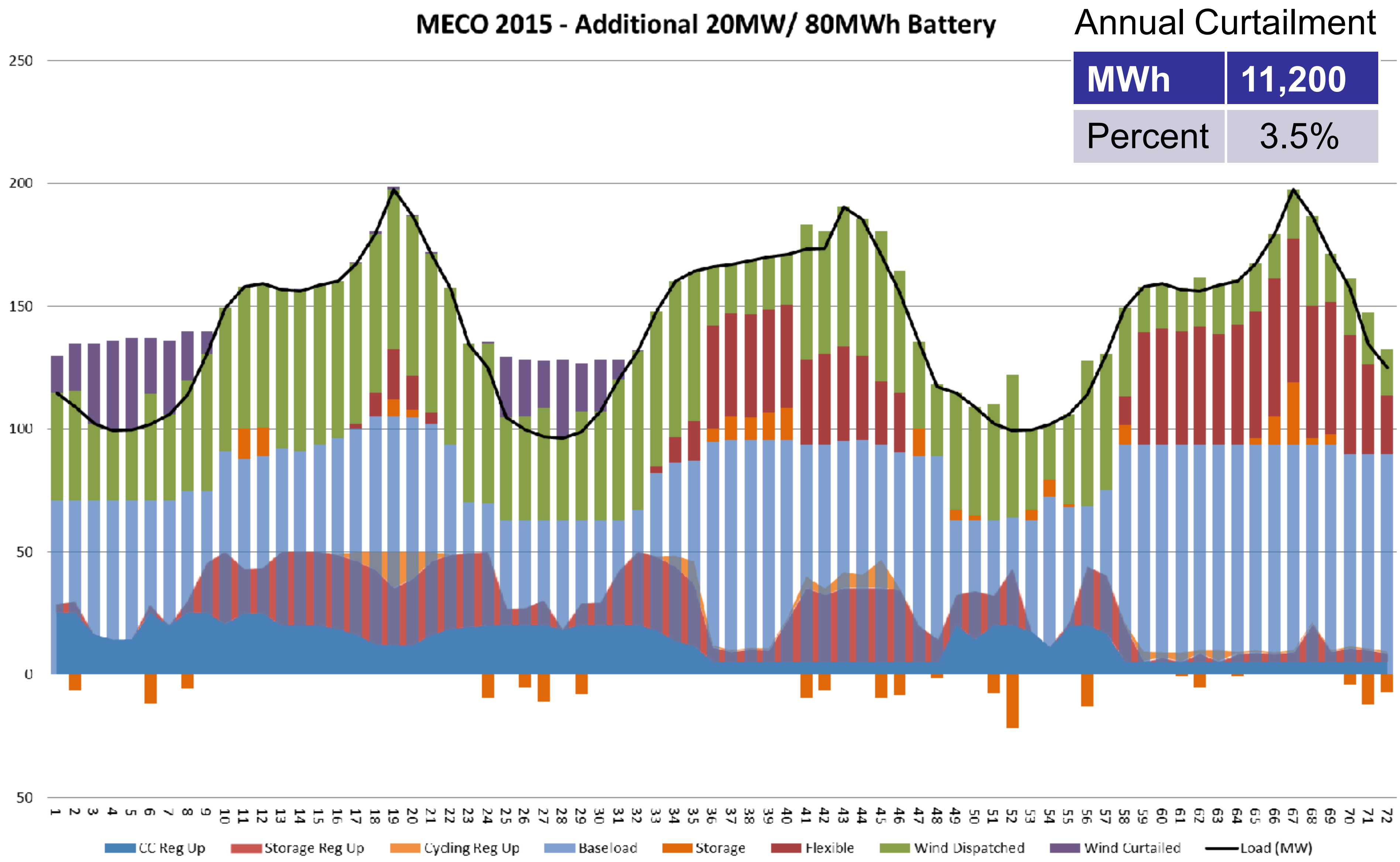
MECO 2015 – 10 MW Battery



Annual Curtailment

MWh	18,600
Percent	6%

MECO 2015 – 20MW / 80MWh Battery



Annual Curtailment

MWh	11,200
Percent	3.5%

What Studies are Possible?

- Solar / Wind Integration Studies
  - What variability in solar / wind causes the rest of the system to do
    - And whether additional resources are required
  - How much in renewables can you add without causing problems
- Evaluation of curtailment mitigation strategies
- Evaluation of benefits of storage, new generation, and transmission line projects
- Long-term integrated resource planning for utilities