State & Federal Energy Storage Technology Advancement Partnership (ESTAP)

Todd Olinsky-Paul

Clean Energy States Alliance

ESTAP is a project of CESA

Clean Energy States Alliance (CESA) is a non-profit organization providing a forum for states to work together to implement effective clean energy policies & programs:

- Information Exchange
- Partnership Development
- Joint Projects (National RPS Collaborative, Interstate Turbine Advisory Council)
- Clean Energy Program Design & Evaluations
- Analysis and Reports

CESA is supported by a coalition of states and public utilities representing the leading U.S. public clean energy programs.

Clean Energy States Alliance

Sandia National Laboratories

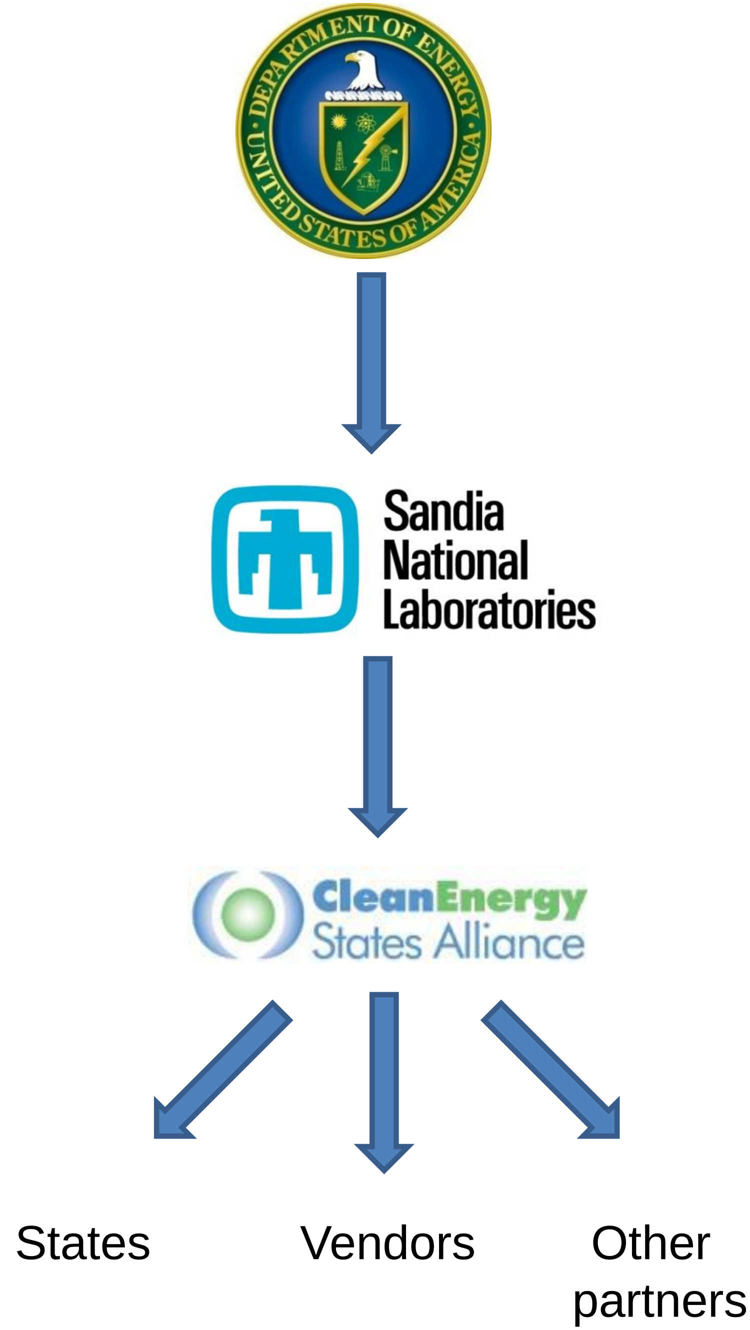
U.S. DEPARTMENT OF ENERGY

ESTAP* Overview

Purpose: Create new DOE-state energy storage partnerships and advance energy storage, with technical assistance from Sandia National Laboratories

Focus: Distributed electrical energy storage technologies

Outcome: Near-term and ongoing project deployments across the U.S. with co-funding from states, project partners, and DOE



* (Energy Storage Technology Advancement Partnership)

ESTAP Key Activities

- Disseminate information to stakeholders
  - ESTAP listserv >500 members
  - Webinars, conferences, information updates, surveys
- Facilitate public/private partnerships at state level to support energy storage demonstration project development
  - Match bench-tested energy storage technologies with state hosts for demonstration project deployment
  - DOE/Sandia provide $ for generic engineering, monitoring and assessment
  - Cost share $ from states, utilities, foundations, other stakeholders

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Thank You:

Dr. Imre Gyuk

U.S. Department of Energy,

Office of Electricity Delivery and Energy Reliability

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Contact Information

Project website:

www.cleanenergystates.org/projects/energy-storage-technology-advancement-partnership/

Recording at www.cleanenergystates.org

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Today’s Speakers

James Ellison, Sandia National Laboratories

Dhruv Bhatnagar, Sandia National Laboratories

Dean Oshiro, Hawaiian Electric Company

Steven Rymsha, Maui Electric Company

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Exceptional service in the national interest

Maui Electric Company Storage Evaluation Project:

A Study for the DOE Energy Storage Systems Program

ESTAP Webinar

Jim Ellison, Dhruv Bhatnagar, and Ben Karlson

March 6, 2013

SAND 2013-1840C

U.S. DEPARTMENT OF ENERGY

NNSA National Nuclear Security Administration

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Project

- Previous studies have indicated that significant levels of wind curtailment on Maui likely
  - Installed wind capacity to increase from 30MW to 72MW by 2015
  - Daily minimum around 70MW
- We were asked to evaluate various energy storage options for Maui, to determine
  - How different storage system characteristics and system operating assumptions impact wind curtailment, and
  - To what degree can energy storage projects be cost-effective

Value of Storage to the Grid

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- 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
- 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
  - The application the resource is used for
  - What it is compared with
  - The size of the resource
- 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
  - Economic dispatch
  - Operating reserves may be function of variable generation

Maui Grid Case Study

Source: Google Maps, March 5, 2013

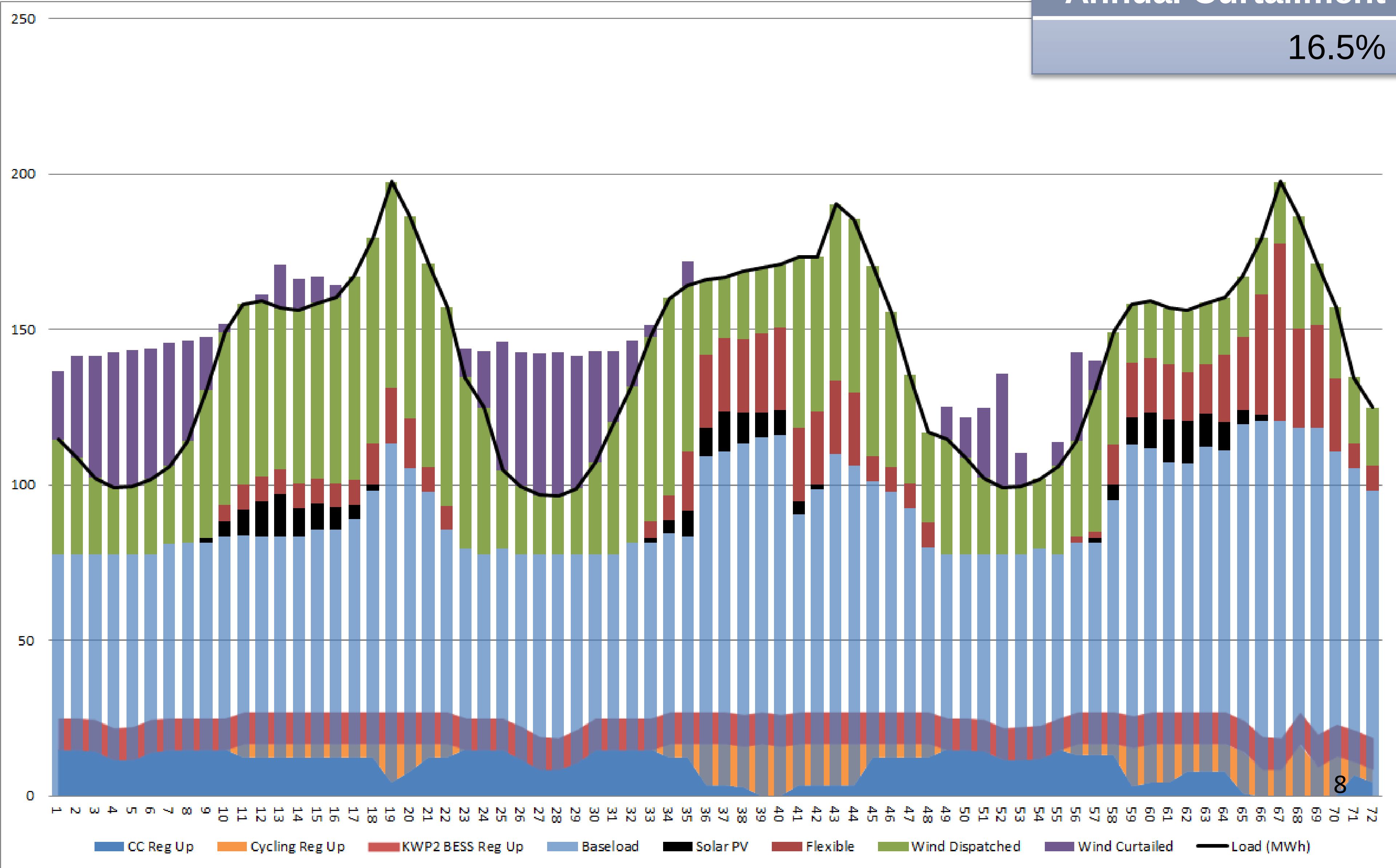
- 210 MW maximum load
  - 70 MW minimum
- Renewable Capacity
  - 72 MW of wind planned
  - 10 MW of biomass
  - 15 MW distributed PV
- Conventional Capacity (diesel)
  - 30 MW of steam
  - 95 MW of reciprocating engines
  - 100 MW of combined-cycle

Study Scenarios

Scenario Name	KPP Operations	Scenario Characteristics of interest
Reference run		
10MW / 15MWh battery	unchanged	spinning reserve value only
10MW / 70MWh battery	unchanged	spin + arbitrage
10MW / 70MWh battery, no K4	K4 not available	spin + arbitrage + K4 off
25MW Waena	K3/K4 not available	spin (w/minimum output) + K3/K4 off
25MW / 175MWh battery	K3/K4 not available	spin + arbitrage + K3/K4 off
25MW / 1200 MWh cryogen	K3/K4 not available	spin (w/min output) + large arbitrage + K3/K4 off
30MW Waena + 5MW/35MWh battery	KPP not available	flexible diesel (spin) + 5MW spin + KPP off
35MW Waena + trans. Line	KPP not available	flexible diesel (spin) + KPP off

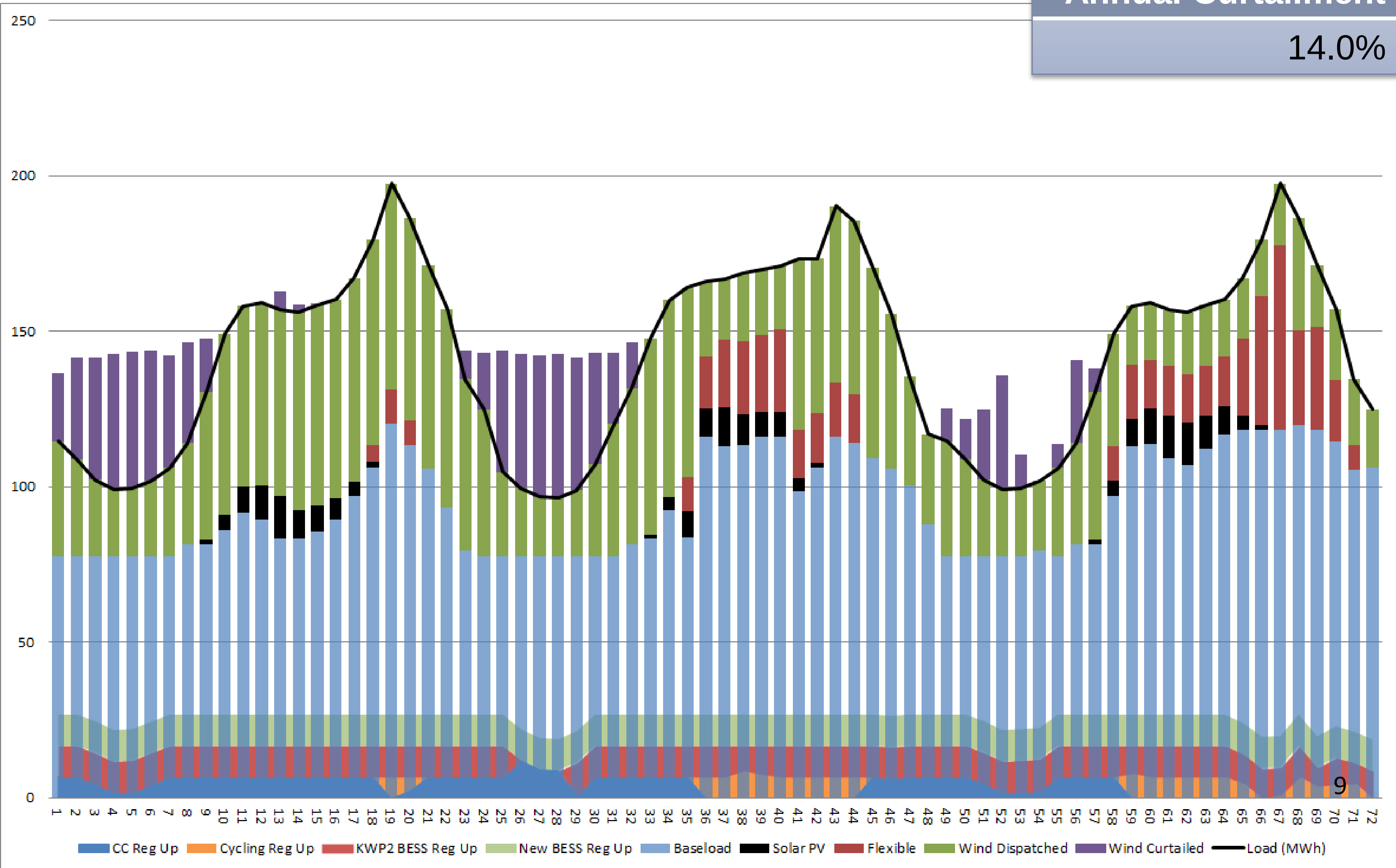
Reference Run

Annual Curtailment
16.5%



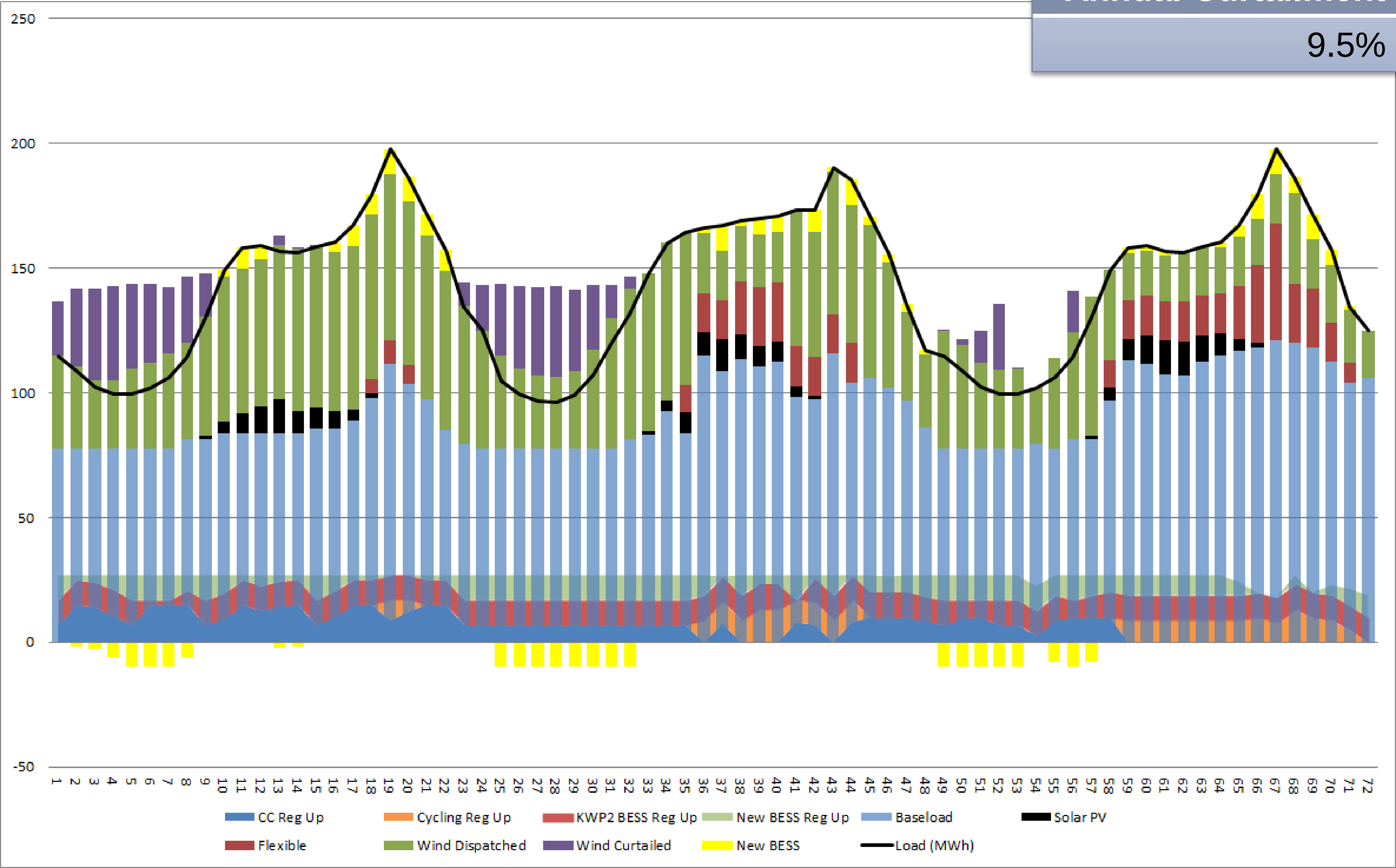
10-MW/15-MWh Battery Scenario

Annual Curtailment
14.0%



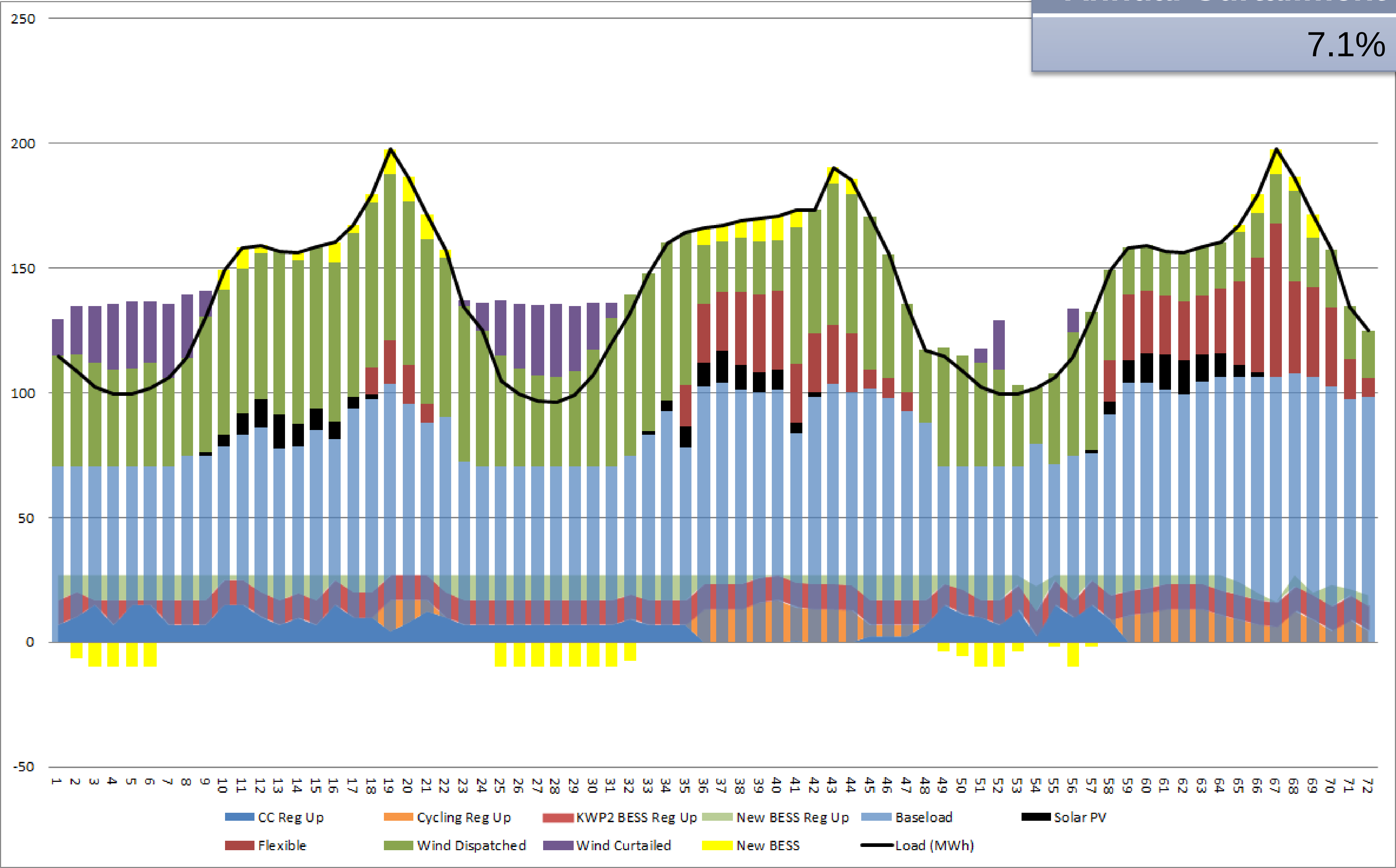
10-MW/70-MWh Battery Scenario

Annual Curtailment
9.5%

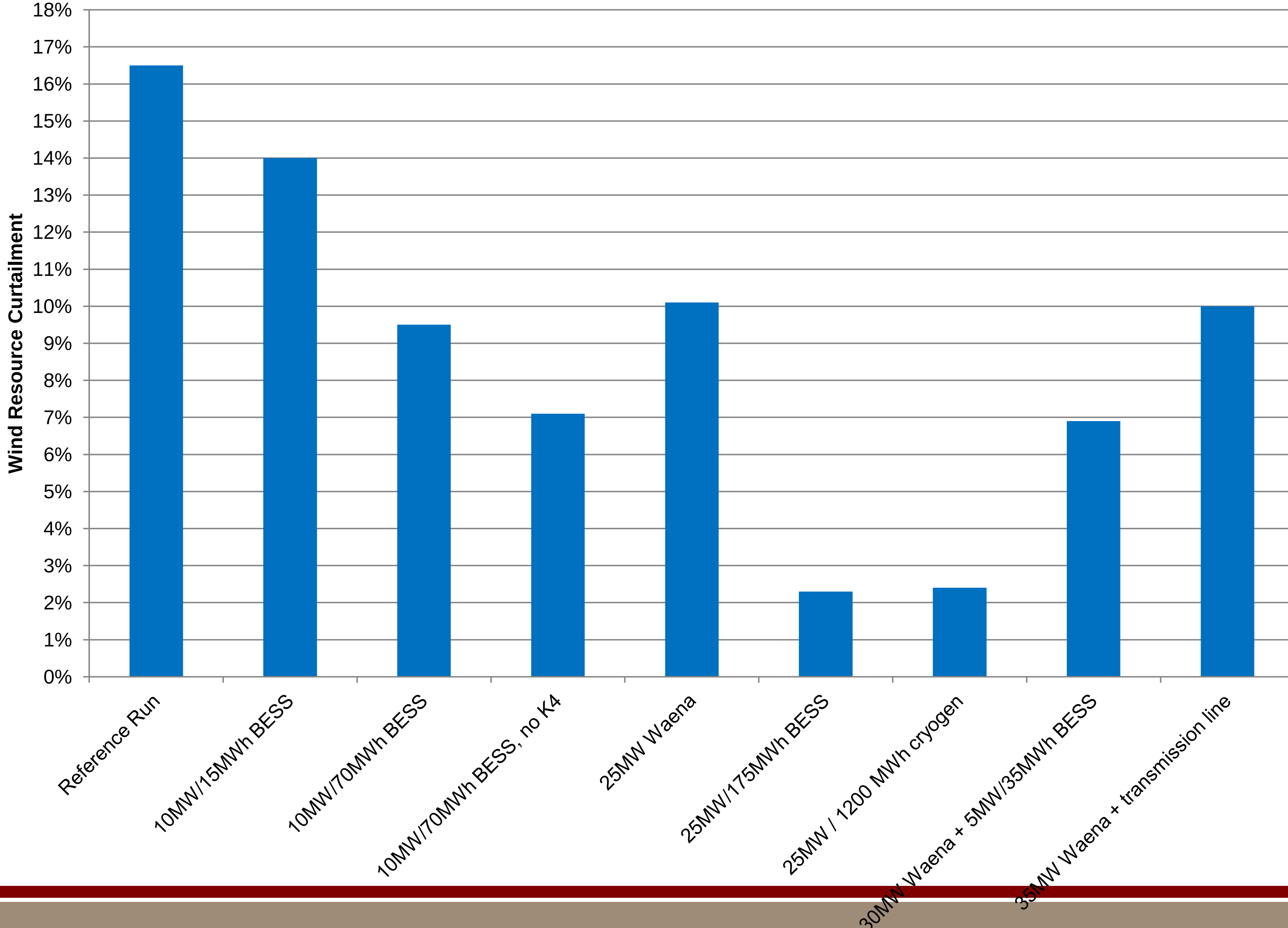


10-MW/70-MWh Battery, no K4

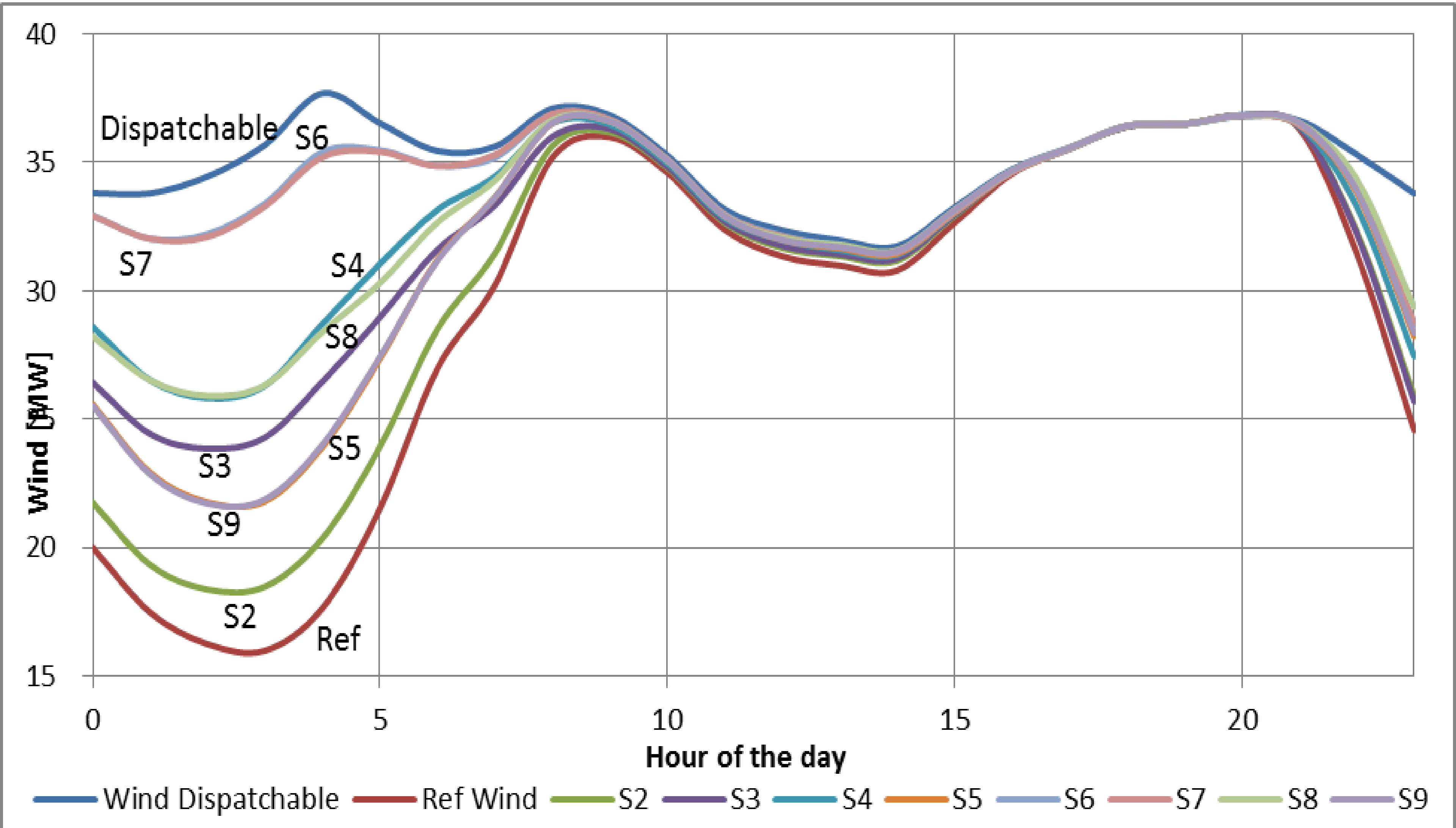
Annual Curtailment
7.1%



Wind Curtailment



Wind Dispatched by Scenario



Economic Characteristics

Scenario (Note: all figures in millions of USD, unless otherwise noted)	Diesel	Wind	Diesel + Wind	Annual Savings	Estimated System Cost	Simple Payback (years)	NPV
Reference Run	194.8	45.0	239.8	-	-	-	-
10MW/15MWh BESS	190.0	46.3	236.3	3.5	11	3.1	34.4
10MW/70MWh BESS	187.7	48.0	235.7	4.1	35	8.5	12.7
10MW/70MWh BESS, no K4	185.9	48.6	234.4	5.4	35	6.5	30.6
25MW Waena	189.8	47.7	237.6	2.2	25	11.4	5.3
25MW/175MWh BESS	180.2	49.4	229.7	10.1	87.5	8.7	29.6
25MW / 1200 MWh cryogen	185.2	49.4	234.6	5.2	31.25	6.0	40.3
30MW Waena + 5MW/35MWh BESS	185.5	48.6	234.1	5.7	47.5	8.3	31.0
35MW Waena + trans. Line	188.9	47.7	236.7	3.1	40	12.9	2.7

Cost Savings Breakdown

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(Note: figures in millions of USD, unless otherwise noted)	Change in Diesel Gen (GWh)	Change in Wind Gen (GWh)	Marginal Diesel Gen cost	Marginal Wind Gen cost	Expected cost diff	Actual cost diff	% due to increased system efficiencies
Reference Run	-	-	-	-	-	-	-
10MW/15MWh BESS	(7.7)	7.6	(1.7)	1.4	(0.31)	(3.5)	91%
10MW/70MWh BESS	(17.4)	21.4	(3.8)	3.0	(0.81)	(4.1)	80%
10MW/70MWh BESS, no K4	(24.7)	28.6	(5.5)	3.6	(1.85)	(5.4)	66%
25MW Waena	(19.7)	19.6	(4.3)	2.8	(1.59)	(2.2)	28%
25MW/175MWh BESS	(33.5)	43.3	(7.4)	4.5	(2.96)	(10.1)	71%
25MW / 1200 MWh cryogen	(8.1)	43.1	(1.8)	4.4	2.66	(5.2)	151%
30MW Waena + 5MW/35MWh BESS	(27.4)	29.4	(6.1)	3.7	(2.40)	(5.7)	58%
35MW Waena + transmission line	(19.9)	19.8	(4.4)	2.8	(1.61)	(3.1)	48%

Conclusions

- All of the scenarios studied provided system savings compared to the reference case
- In the scenarios with additional storage alone, 2/3 or more of the system savings is from the more efficient operation of the conventional units
  - The efficient combined-cycle blocks, which typically provide spinning reserve, operate at higher levels with a storage system in place
  - Peaking units are not operated at minimum load to provide reserve
- Adding storage capacity to the 10MW battery helps to decrease wind curtailment
  - But does not increase the efficiency of conventional unit dispatch

Conclusions, contd.

- Storage provision of spinning reserve increases the efficiency of conventional unit use
  - Time-of-day shifting facilitates the dispatch of more wind
- Economics of time-of-day shifting depend on capturing large volumes
  - For two of the wind farms, PPAs specify volume discounts
- Waena biodiesel plants do not rank highly in terms of NPV
  - However, they allow the system to replace 150GWh/year of residual fuel-fired generation, at a net reduction in system operating cost
    - Even though they are required to burn biodiesel, which is about 3 times more expensive than residual fuel
- Significant upside to the Cryogen scenario if efficiencies can be increased above 50%

Future Tasks

- Is this study sufficient for MECO to make a decision on whether to install additional grid-level storage?
  - If not, what else is needed?

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