Puerto Rico's 20 MW Battery Energy Storage
The World's Largest Lead Acid Battery System Is Repowered

California Energy Commission
U.S. Department of Energy
Workshop on Electricity Storage

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Science Applications International Corporation
An Employee-Owned Company

Battery System Building in Puerto Rico

Long-Term Interest in Energy Storage

- Puerto Rico Electric Power Authority (PREPA) began investigating technologies in mid-1980s
- Evaluated batteries, SMES, and flywheel options with U.S. Department of Energy (DOE) assistance
- Original 20-MW facility was the world's largest energy storage system until it ceased operation in 1999
- Utility purchased land adjacent to plant in order to build a second facility
- Utility management is tied to political cycle so things take longer in Puerto Rico
- Maintenance of older power plant equipment and post-hurricane restoration are top utility priorities

Energy Storage Provides

Rapid Spinning Reserve for Island Grid

Prevent load shedding of 45-80 MW when one of island's largest generators shuts down (Balance new coal-fired cogenerator)

Large Transmission Losses

Location of power plants and limited 230 kV lines force most electricity to be transmitted long distances over 115 kV lines

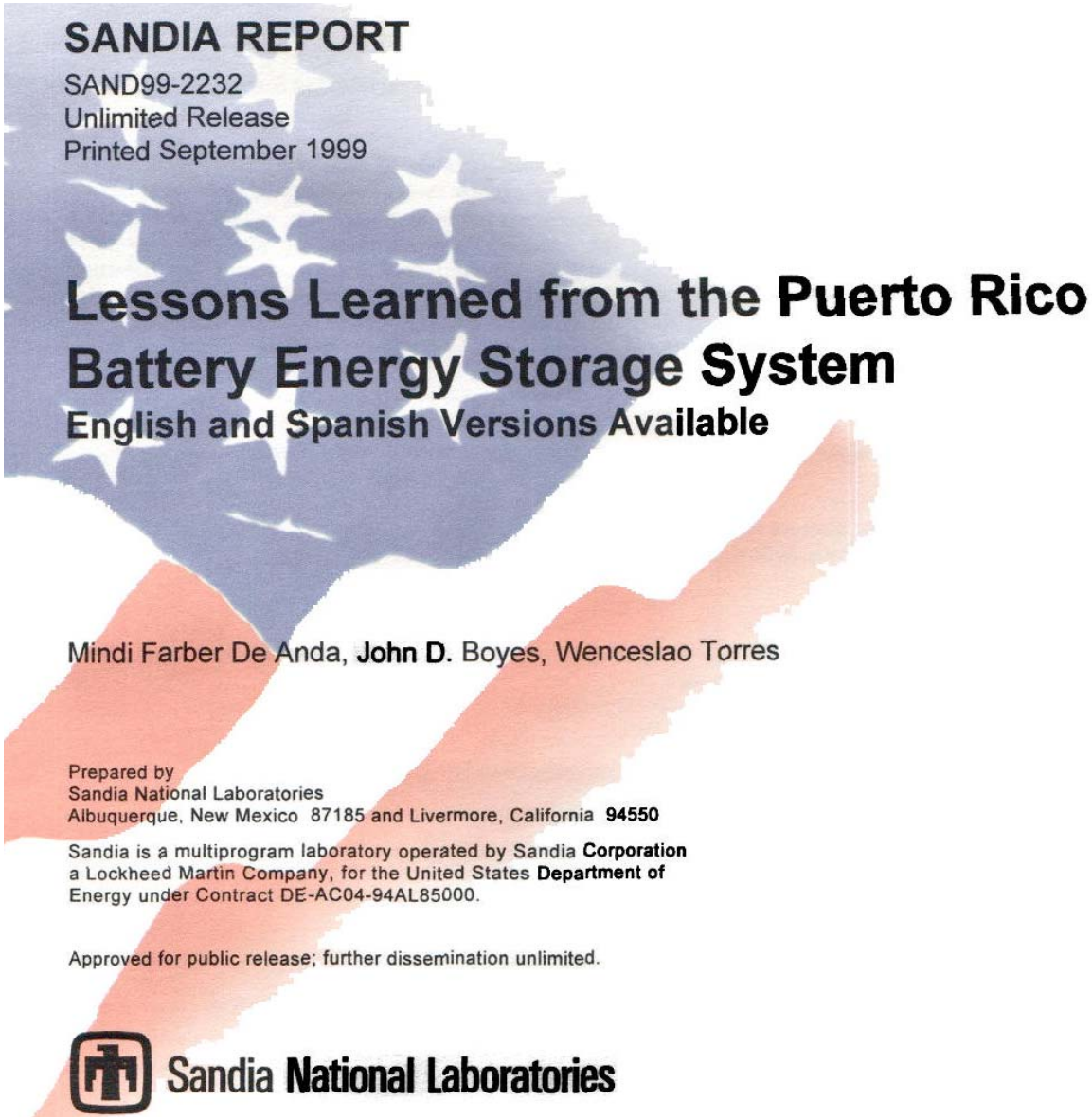
Frequency Regulation Needs

Inject +/- 10 MW proportional to frequency deviation from 60 Hz

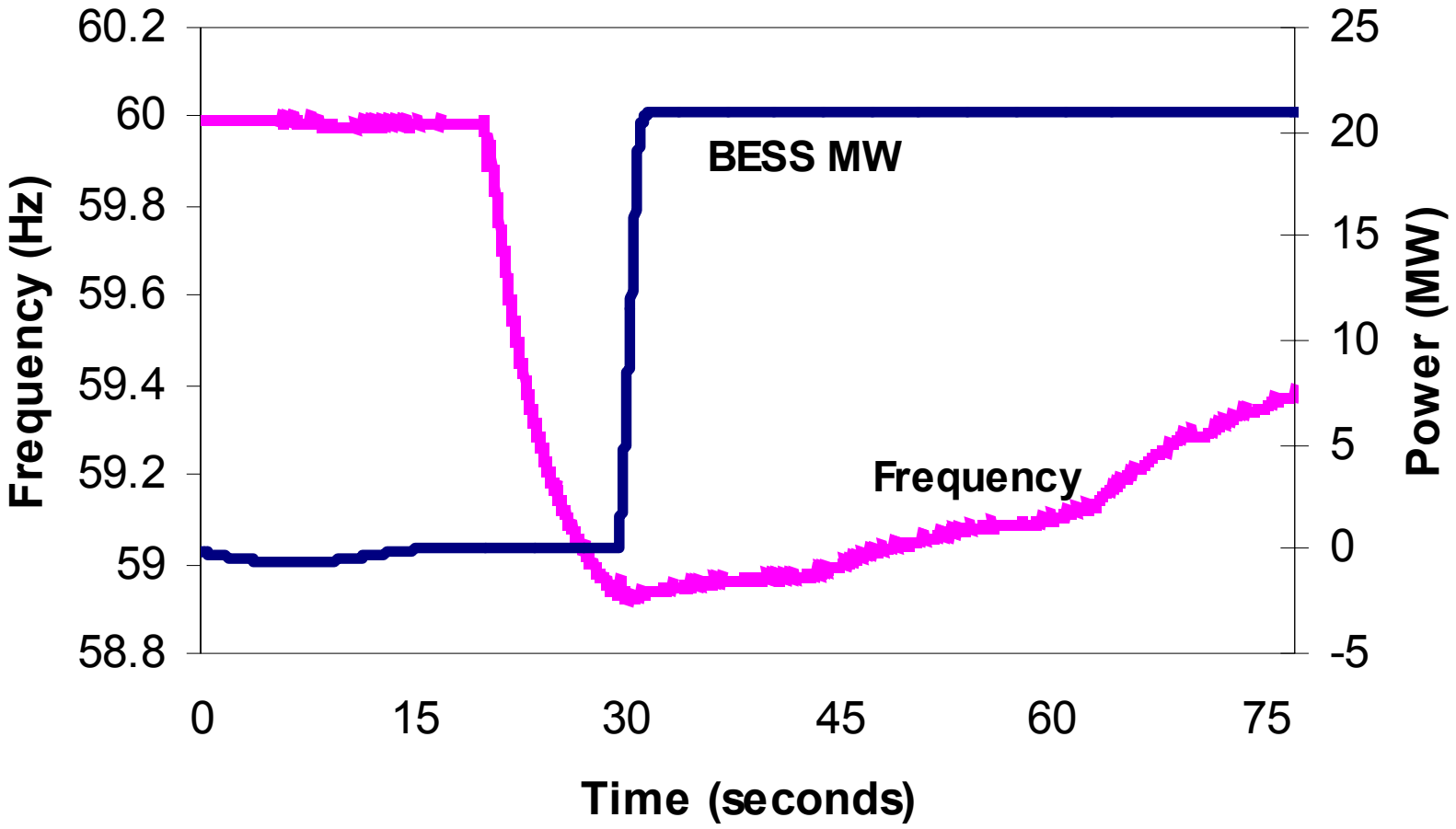
Voltage Control Needs

Operate like a synchronous generator or condenser, injecting 20 MVAR or absorbing 15 MVAR reactive power

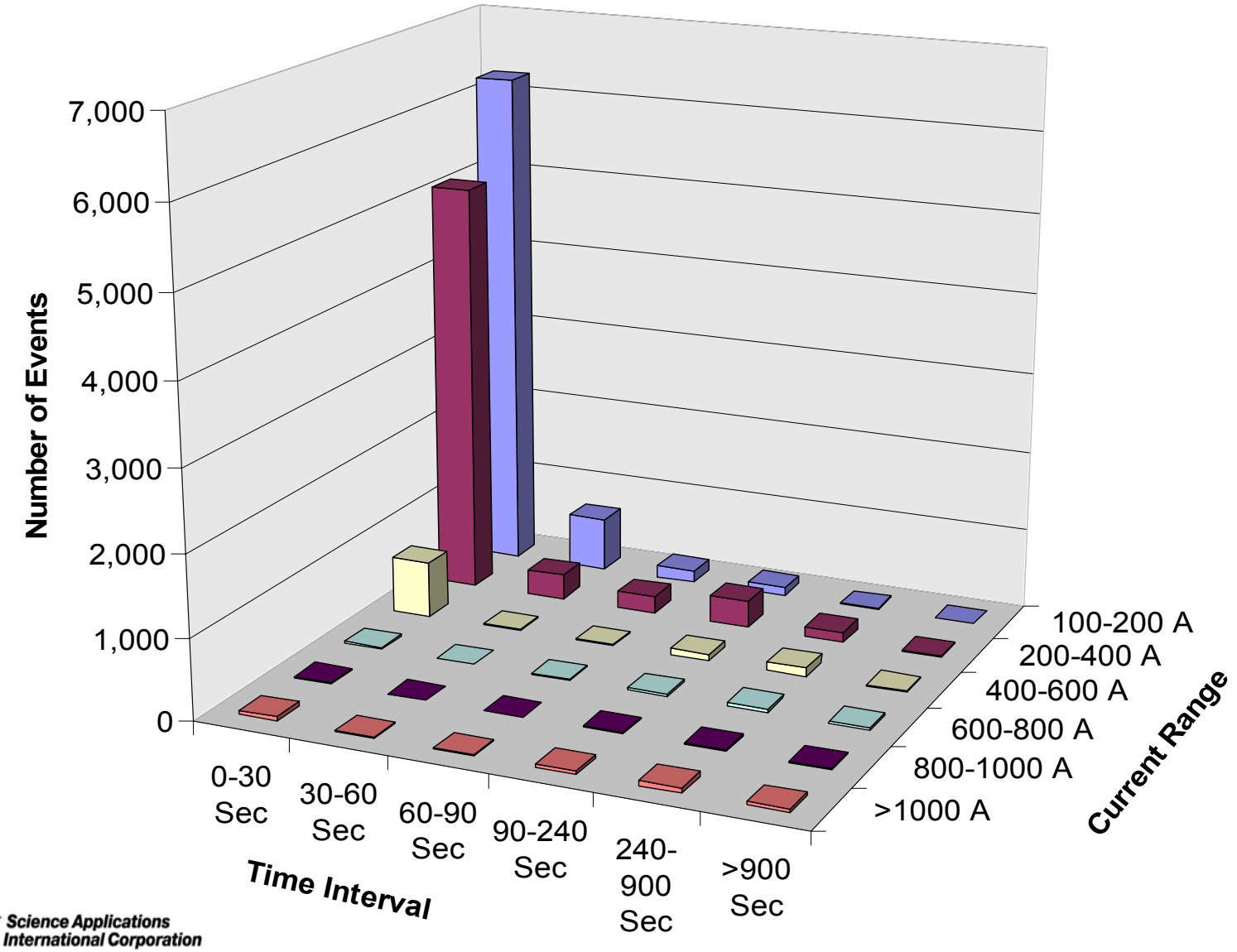
DOE Documented the Lessons Learned



Spinning Reserve Response on May 2, 1997



Frequency Regulation Responses 1997



Project Schedule Comparison

Energy storage systems are multi-year projects.
Need to overcome obstacles in all project phases.

Project Phase	First Installation	Repowering
Planning	Jan 1989-May 1990	Jan 1999-2001
Design	May 1990-Oct 1992	Jan-Dec 2000
Procurement	Jan 1991-May 1993	1st Bid Nov 2000 cancelled 2nd Bid May 2003 awarded
Construction	July 1992-July 1994	May 2003-Aug 2004
Inauguration	***July 1994***	***August 2004***
Start-Up	July 1994-June 1995	Aug 2004-Apr 2005
Operations	Nov 1994-1999	8 years from commissioning

Project Scope Comparison

PREPA is the owner, operator, and funding source. Features of both projects are the same except for:

Features	First Installation	Repowering
Scope	Entire project	Cell/rack replacement Building retrofit Facility control upgrade
Type/Mgmt	PREPA managed 8 different contractors	Turnkey project by Passco/Induchem
Cost	$20.3 million	$11.5 million
Cells	6,000 C&D flat plate lead calcium alloy	6,048 NIFE Lorica tubular lead acid
Facility Control	MAX 1000	MAX 1000+++
Capacity	2,265 Amp-hours	2,700 Amp-hours

New Cell Characteristics

- 6,048 Lorica 29TH95 cells
- Tubular lead acid, antimony alloy on positive plates
- 8 year warranty
- 15 minute discharge allows for
  - 10 minutes max output @ 20 MW
  - 5 minutes ramp down to 0 MW
- 60% state of charge available for rapid discharge
- Discharge to 40% state of charge on frequency regulation
- 5-hour recharge

Photo courtesy of Peter Stevenson, Yuasa UK

Current Status

- Original cells removed from building and recycled
- New contract signed May 10, 2003
- NIFE began producing cells on May 30, 2003 with delivery completed by August 15, 2004
- Building retrofit completed
  - Door, elevator, water demineralization plant, air conditioning
- New facility control system delivered and programmed
- General Electric working to stability PCS, replace corroded parts (facility sat idle for three years)
- Repowered plant undergoing start-up

Recent Plant Views

One of Three Rows in Each String

Close-up of Lorica Cell for Display Purposes

Power Conditioning System

Transformer Yard

Photos courtesy of Peter Stevenson, Yuasa UK

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Contact PREPA to receive more information or arrange a visit