The Economic Value of Power Quality and Electricity Reliability

U.S. Department of Energy
Energy Storage Program Review

Joe Eto
Lawrence Berkeley National Laboratory
510 486 7284 – jheto@lbl.gov
http://certs.lbl.gov

November 20, 2002

←Home
←Agenda

BERKELEY LAB

Overview

- Estimates of the economic cost of reliability have been growing over time
  - Rolling blackouts, recent major reliability events have heightened pubic awareness
- Power quality is an increasingly important element of electricity reliability for key sectors of the economy
  - There are disconnects between customer's and utility's views on electricity reliability
- DOE is working to improve and increase the availability of information on electricity reliability in the public domain
  - I-Grid Pilot Demonstration
  - Integration of Utility Interruption Cost Surveys
- Work was initiated under OPT Analysis; technical oversight provided by Imre Gyuk, Energy Storage, and Phil Overholt, Transmission Reliability

What is the Cost of Unreliable Electricity to the U.S. Economy?

"$26 billion/yr." Clemmensen, 1992

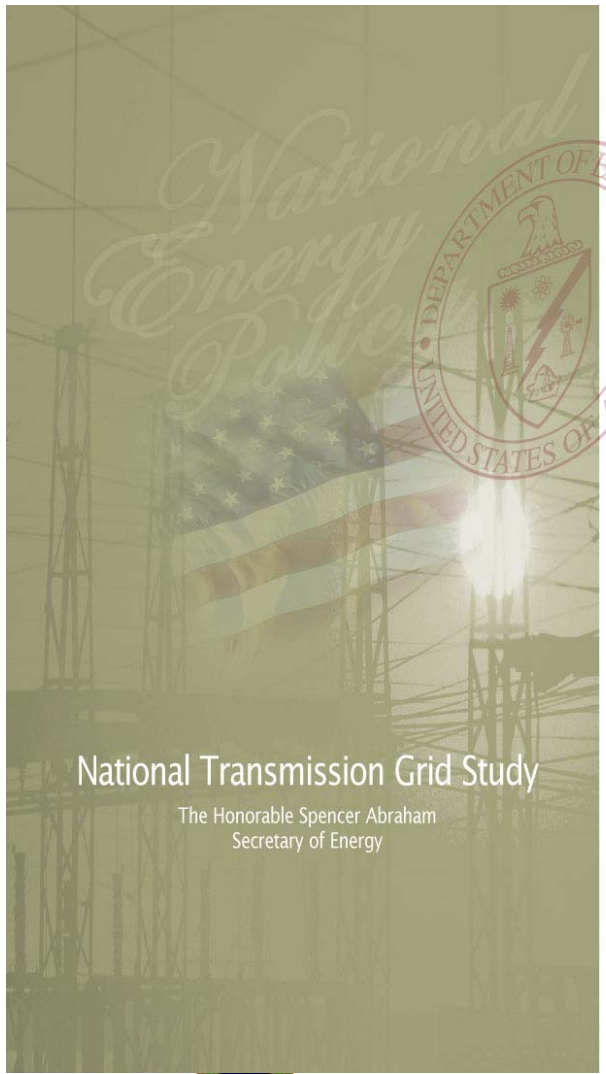
"$50 billion/yr." EPRI 1996, citing Clemmensen

"$100 billion/yr. In five years" Banc of America 2000, citing EPRI

"$150 billion/yr." DOE/Sandia 1998

"$119-164 billion/yr." EPRI/Primen, 2001

DOE National Transmission Grid Study



DOE will work with the Energy Information Administration (EIA), FERC, National Governors Association (NGA), the National Association of Regulatory Utility Commissioners (NARUC), the National Association of State Energy Officials (NASEO), industry, and consumer representatives to **determine what economic and reliability data related to the transmission and the electricity system should be collected at the federal level and under what circumstances these data should be made publicly available.**

DOE will work with FERC, state PUCs, and industry to **ensure the routine collection of consistent data on the frequency, duration, extent (number of customers and amount of load affected), and costs of reliability and power quality events, to better assess the value of reliability to the nation's consumers.**

BERKELEY LAB

The Growing Significance of Power Quality

" 'Nines' are in the eyes of the beholder."

Normal Utility

Normal Utility Events	Process Uptime 1 Hr Downtime per Event	Typical Applications
25events/yr 22 @ ¼ sec 1 @ 2 secs, 1 @ 5 mins, 1 @ ½ hr, 2,107 sec/yr	25 Hrs total downtime / yr,	Plastics, PCs, Machinery, Textiles, Cell Towers, Residential
99.99% 4-nines	99%, 2-nines	

Premium Utility

Premium Utility Events	Process Uptime 1 Hr Downtime per Event	Typical Applications
10 events/yr, 0.25 sec each 2.5 sec total / yr,	10 Hrs total Downtime / yr,	Semicon Mfg, Auto Mfg, Fiber Optic Cables, Web farms, Continuous Processes
99.99999% 7-nines	99%, 2-nines	

Major disconnect exists between a utility and a 'digital economy' customer's perception of reliability.

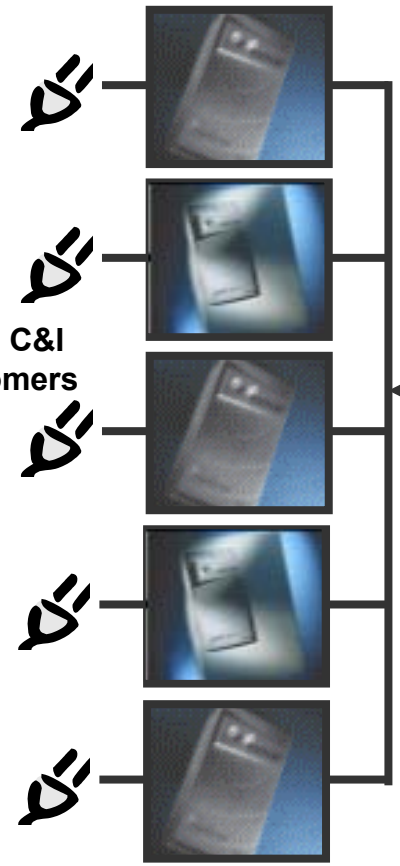
DOE I-Grid Pilot Project

- Demonstrate low-cost PQ monitoring system
- Deploy ~ 50 monitors in partnership with Silicon Valley Manufacturer's Group
- Participating firms include HP, Analog Devices, Applied Materials, NUMI, SJSU (in discussions with 4 add'l firms)
- Data are shared with participants via web-site interface
- Initial data collection period: Jul-Dec. 2002
- Data will be used to conduct proof-of-concept analysis of PQ data in support of creation of a new national power quality benchmarking study

i-grid.com
Power Data Empowering People

I-Sense™ monitors record & report PQ event data to the I-Grid™ server using an internal modem via the Internet

Use a web browser to:
- View PQ event data, current & historical
- Manage your account & I-Sense monitor/s
- Generate reports



Utility C&I Customers

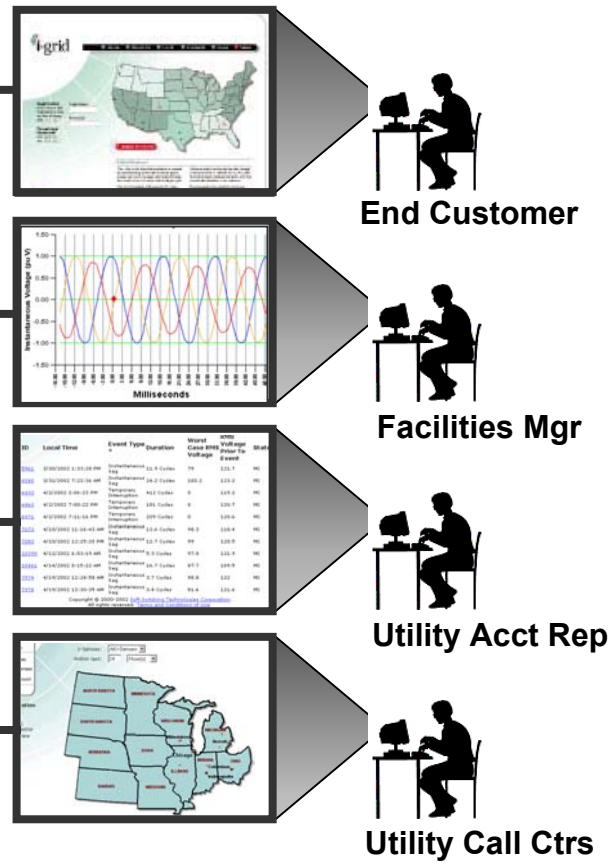
$195 – 1 Phase
$295 – 3 Phase

Internet

I-Grid™ server archives event data in a relational database, & provides aggregation & reporting capabilities

I-Grid™ Server / Database / Aggregation Engine (AE)

Internet



End Customer

Facilities Mgr

Utility Acct Rep

Utility Call Ctrs

Email

I-Grid™ server provides real-time email/pager notification to customers and to utility

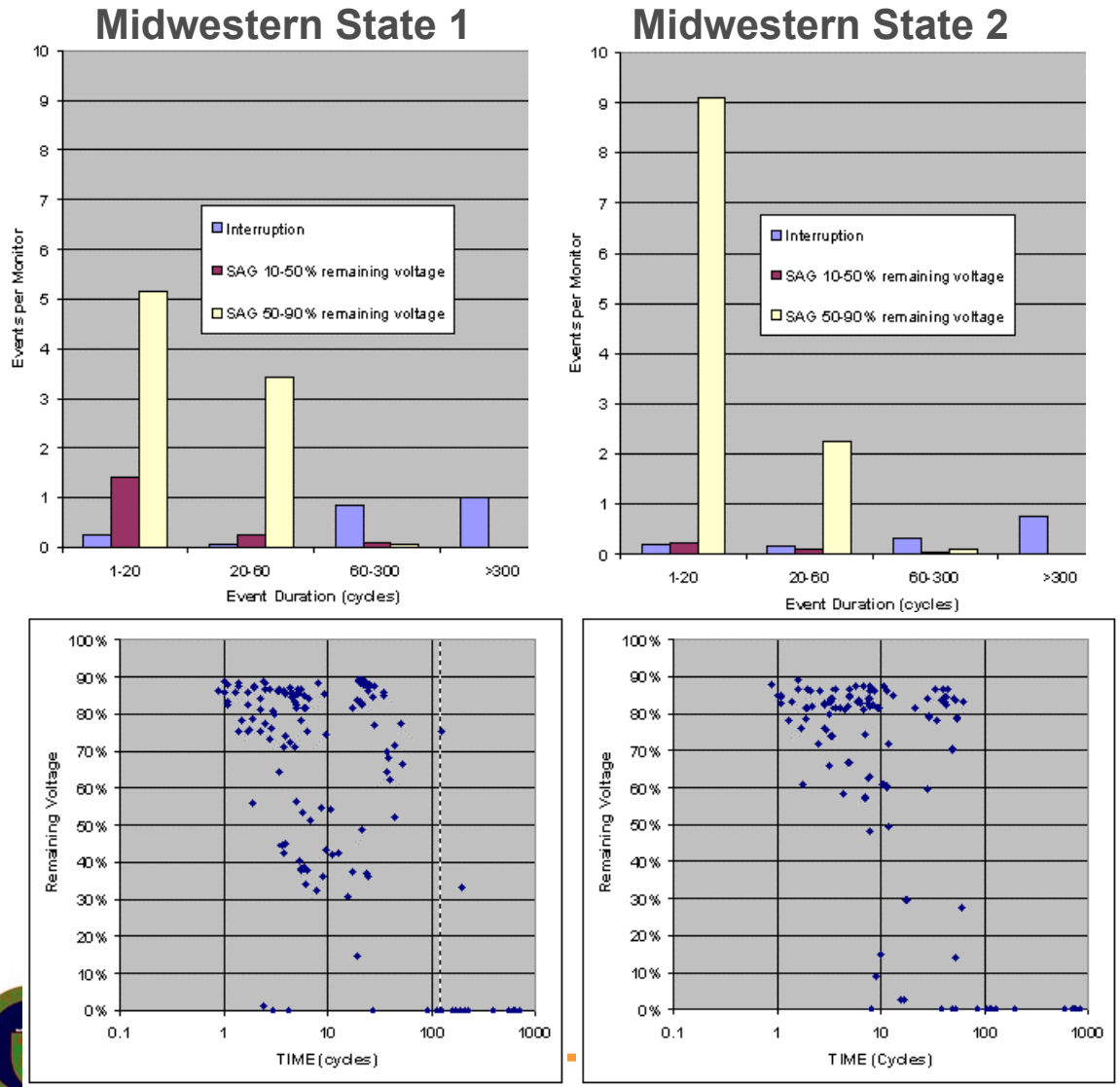
Early Results Confirm Value of I-Grid Approach

Owner	Monitor	9/29/02	10/19/02	11/7/02
Firm 1	node 1		8:22:47 AM	11:41:29 PM
Firm 1	node 2		8:22:47 AM	11:41:29 PM
Firm 1	node 3	2:45:03 PM	8:22:47 AM	11:41:29 PM
Firm 1	node 4	2:45:03 PM	8:22:47 AM	11:41:29 PM
Firm 1	node 5	2:45:03 PM	8:22:47 AM	11:41:29 PM
Firm 1	node 6	2:45:03 PM	8:22:47 AM	11:41:28 PM
Firm 2	node 1			11:41:29 PM
Firm 2	node 2			11:41:28 PM
Firm 2	node 3			11:41:28 PM
Firm 3	node 1			11:41:29 PM
Firm 3	node 2			11:41:29 PM
Firm 4	node 1			11:41:28 PM
Firm 4	node 2			11:41:29 PM
Firm 4	node 3			11:41:28 PM
Firm 4	node 4			11:41:29 PM
Firm 5	node 1			11:41:28 PM

National Power Quality Benchmarking Study

- Last major study of utility power quality is over 8 years old; study results are proprietary
- DOE is exploring development of a living national repository of PQ information based in part on the I-Grid
- Summary information must be available in the public domain – customer-specific and utility-specific confidentiality can be protected
- DOE expects significant industry involvement; utilities, PUCs, and EPRI are welcome partners

PQ Benchmarking Example: State-Level Event Statistics



BERKELEY LAB

LBNL is Integrating Utility Interruption Cost Studies to Develop Regional Outage Cost Estimates

- Southern California Edison (2000)
- Pacific Gas and Electric (1986, 1987, 1989, 1993, 1996)*
- Southern Company (1987, 1991, 1998)
- Duke Power (1993, 1997)
- Bonneville Power Administration (1987)
- Salt River Project (2000)*
- Puget Sound Energy (1999)
- Cinergy (1998)*
- MidAmerica (2002)

~25,000 customer responses

*discussing participation

BERKELEY LAB

Example Data Variables - Residential

Scenario Specific to Outage Cost Calculations

- Season
- Hour of day
- Day of week
- Duration
- Warning given
- Outage Cost per event
- Outage Cost per kWh
- Measurement type

Respondent Specific Demographic and Other Descriptor Variables

- Year of survey
- Geographic region
- Heat/cooling indices
- Housing type and ownership
- Sick Bed/Medical & med. equipment.
- Home business
- HH Income
- Number of outages
- Back-up generator
- Average KW usage
- Grid Area

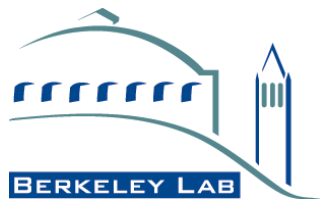
Sample Outage Cost Equation

TABLE II.
RESULTS OF REGRESSION ANALYSIS
PREDICTING OUTAGE COST FOR A FOUR-HOUR OUTAGE
WITHOUT NOTICE STARTING AT 3:00 PM IN SUMMER

Dependent Variable: Log of customer Outage Cost
R-square = 0.62518443

	DF	Sum of Squares	Mean Square	F	Prob>F
Regression	15	61.25141907	4.08342794	12.9	0.0001
Error	116	36.72194032	0.31656845		
Total	131	97.973355939			

Variable	Parameter Estimate	Standard Error	Type II Sum of Squares	F	Prob>F
INTERCEP	-0.96204513	0.60715473	0.79480347	2.51	0.1158
D_BACKUP	-0.22747674	0.11691312	1.19843686	3.79	0.0541
LKWH_M	0.90900914	0.09907528	26.64854522	84.18	0.0001
Processes:					
CUTTING	-0.3543408	0.18567439	1.15293801	3.64	0.0588
DRILLING	-0.49743701	0.15039917	3.46300354	10.94	0.0013
HEAT TREATING	-0.40782494	0.21467539	1.14248546	3.61	0.06
KNITTING	-2.44749491	0.57688469	5.69814106	18.00	0.0001
MACHINING	-1.18036554	0.29481696	5.07452905	16.03	0.0001
PACKAGING	-0.65838674	0.22855185	2.62700127	8.30	0.0047
SLASHING	0.85184842	0.40825287	1.37826836	4.35	0.0391
STAMPING	-0.39516021	0.19317661	1.32466162	4.18	0.0431
Equipment Types:					
NETWORK CONTROLLERS	0.27594666	0.10338631	2.25523515	7.12	0.0087
OPENING LINES	0.79247017	0.26410661	2.85019746	9.00	0.0033
TWISTING MACHINES	1.70184339	0.28944047	10.94430804	34.57	0.0001
CARDING MACHINES	-0.79901494	0.2381323	3.5640256	11.26	0.0011
Backup Generation:					
FLYWHEELS	0.40473101	0.10389352	4.80422867	15.18	0.0002



Where Are We Going From Here?

- Continued focus on customer's perspective - there is a continuum between electricity outages and power quality
- Improve and increase availability of information on electricity reliability in the public domain
- Develop a framework for on-going assessments of what is and is not known about electricity reliability costs
- Continue primary data collection on power quality events and their effects on customers – I-Grid Pilot Project
  - Toward a living, national public database on power quality events
- Consolidate massive "gray" literature on customer interruption costs (utility studies, utility reliability performance)

A more robust national estimate of the economic value of electricity reliability

↑Top

←Agenda

BERKELEY LAB