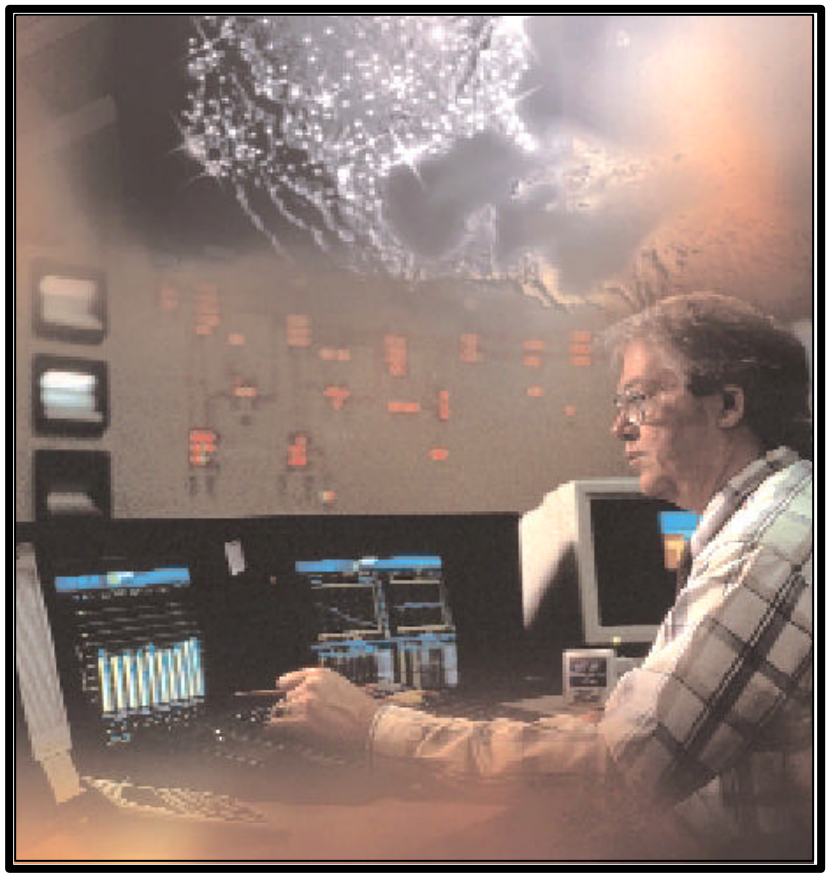
Powering "Digital-Loads"

(And The Importance Of Energy Storage Technologies)



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Phased Approach To Serve New Digital-Loads

Follow Three-Step Phased Approach

- Determine reliability and availability of existing feeder(s) that could serve the new Digital-Load(s)
- Determine reliability and availability needed by the new Digital Load(s). Be sure to categorize customer plant components to segregate load into "reliability-classes")
- Determine best option to fill "gap" between the two items above. See next vu-graph for some of these options
- Participate in EPRI's Reliability & CEIDS Initiative To Get Access To, And Help Develop and Demonstrate The Latest Digital-Quality Power Technology Options (With Energy Storage Options)

Notes:

1) This approach is currently being carried out by AEP and EPRI on the "Premium Power Park" project
2) CEIDS = Consortium for Electric Infrastructure to Support a Digital Society

Options To Fill Gap Between Existing Feeder Reliability and Customer Needs

Design & Cost Studies Are Used To Pick "Best" Option: Some Options Are Below With Details/Examples Following:

- Double (independent) circuits to Digital-Load with fast-acting solid-state switch (if each circuit cannot be operated at half load)
- One circuit with dedicated local generation and storage as backup; i.e., EPRI's UPS Substation approach. Each Digital-Load is in same region and is greater than about 10 MW's. Includes Distributed Resource options (generation & storage).
- Premium Power/Quality Park with local dispersed voltage support and storage units; ie, the EPRI Power Quality Park approach. It is best when all Digital-Loads are in a single confined region and the total aggregated load is below by about 10 MW's.
- Dynamic Voltage Restorer (DVR) which has built-in storage
- Static-VAR Converter (SVC) which needs storage added
- Superconducting Cable to deliver to "Digital Hotel" 50 to 150MW
- Critical "9x9" loads served by dedicated "9x9" bus using one or more of the above options
- UPS's within Digital-Load plant on critical components

Don't Forget Common Sense Realities

- A number of technologies are available and used today to resolve today's reliability and/or power quality problems
- The "best" technology to choose depends on the problem at hand and its MW scale.
- Often, energy storage technologies are integral to the solution, and at other times energy storage technologies add new features (e.g., VAR, PQ control) to the solution
- Energy Storage advocates need to recognize they have to compete with other technology options
  - Cost and Technology Maturity Are Key Issues

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The Reliability Challenge

- Power delivery process becoming more complex
- Increasing bulk power transactions strain grid capacity
- Transmission expansion is not keeping up with load and generation growth
- Incentives for transmission expansion are lacking
- Wire's infrastructure in USA needs to be upgraded very soon

Rise of the Digital Economy

- Phase 1 -- Computers
- Phase 2 -- Embedded Processors
  - Now there are 30 times as many stand-alone chips as in personal computers
- Phase 3 -- Networks
  - One million+ Web sites
  - 200 million+ computers worldwide
  - E-commerce = 2%+ of American GDP

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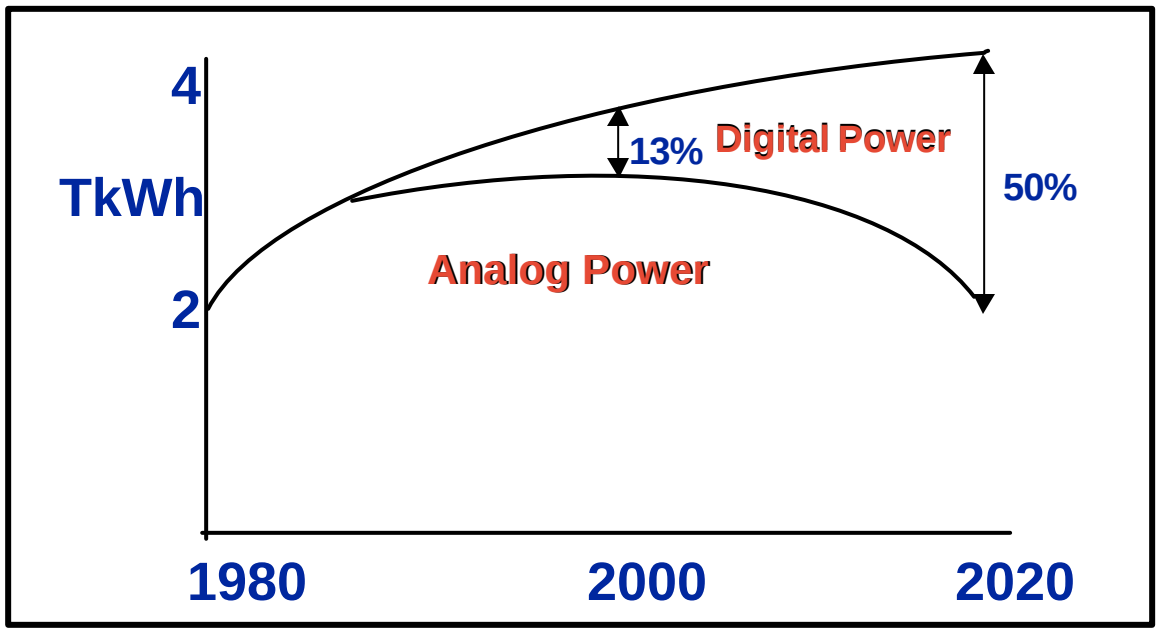
Challenges for Electric Power

- **Quantity**
  - Information Technology (IT) alone accounts for 10-13% U.S. energy consumption
  - 80% energy growth is being met by electricity
- **Quality**
  - Grid delivers 3-nines reliability (99.9% reliable)
  - Microprocessors require 9-nines reliability (99.9999999%)
  - Even brief outages can cost a company millions of Dollars

Rise of the Digital Economy



Demand for "Digital Quality" power is growing rapidly

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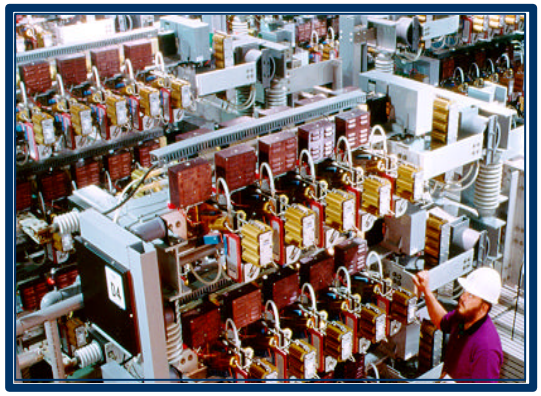
Two Reliability Goals



- Increase transmission capacity and enhance reliability to support a stable wholesale power market
- Upgrade distribution and transmission infrastructure to support integration of low-cost power from transmission system with new DR options

Don't Try To Only Gold-Plate The T&D Grid: That Won't Do The 9x9 Job

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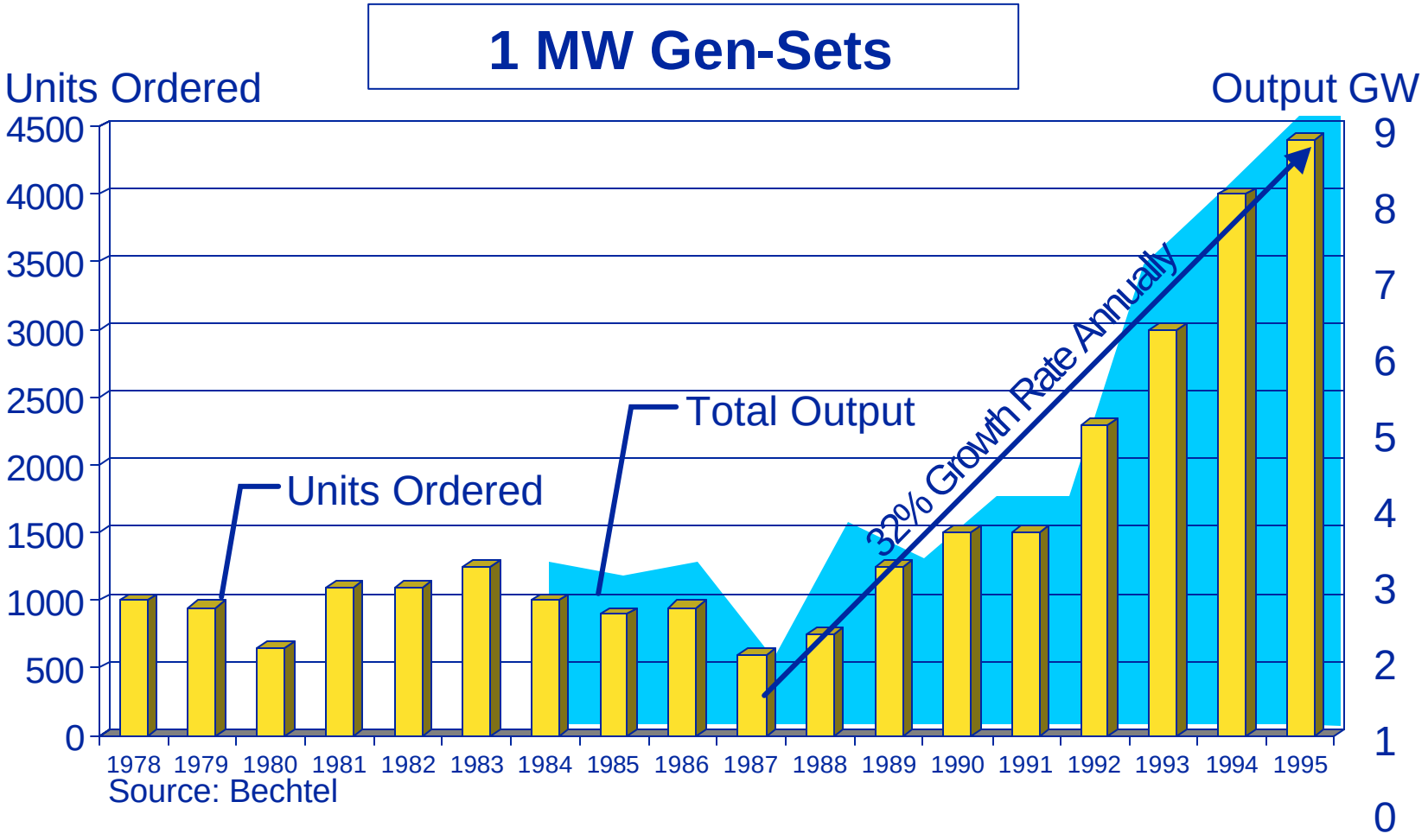
The Effect On Silicon Valley

- **"The impact of momentary interruptions of power is extremely costly in terms of lost productivity and potentially damaged equipment at Oracle….Whether the electricity was free, or cost three times as much, would have absolutely no effect on the cost of our product." - Mike Wallach**

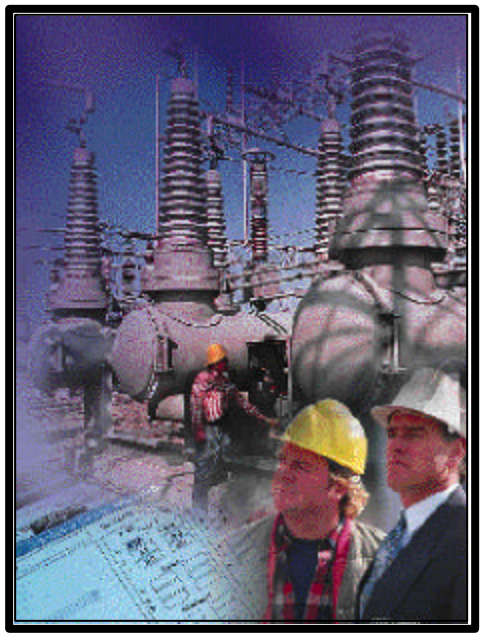
- **"What is self-sufficiency worth to us [Oracle]? Millions of dollars per hour." - Jeff Byron**

- **"Sun Microsystems has estimated that a blackout costs up to $1 million per minute" - Larry Owens, Silicon Valley Power**

Consumer Response: Market for Backup Power Takes Off



EPRI Response



- **Short Term:**

  EPRI's Reliability Initiative
  - **Phase I Completion Scheduled For 2Q, 2001**
  - **$6M Program, 44 Utilities**
  - **Phase II Recommended By Current Funders**

- **Long Term:**

  Consortium for Electrical Infrastructure to Support a Digital Society (CEIDS)
  - **Start Date Scheduled For 3Q, 2001**

Reliability Initiative

Primary Focus:

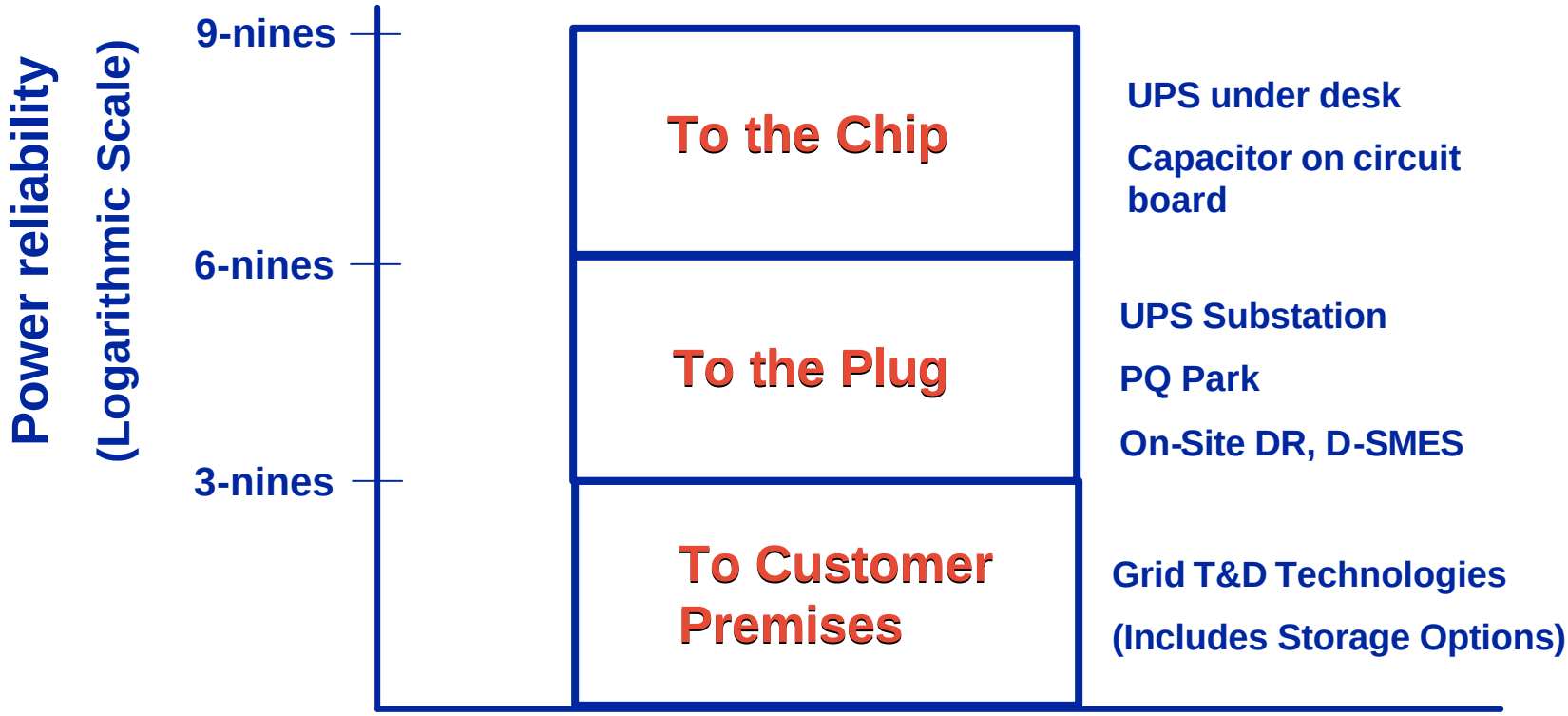
- Develop an understanding of the root causes of recent major power outages
- Identify underlying problems in both Transmission And Distribution networks
- Identify actions and/or technologies that will help enhance system reliability and fix problems

Note: This Initiative represents the first time newly developed probabilistic tools are being used to comprehensively assess the vulnerabilities in the North American power grid.

Digital Society Initiative

- **CEIDS: Consortium for Electrical Infrastructure to Support a Digital Society**
- **Structure of Initiative based on broad industry participation**
  - **Users of "Digital Electricity"**
  - **Equipment Suppliers/Vendors**
  - **Electric Utilities**

Meeting the Reliability Challenge
(Simplified 9 X 9 View)



A combination of technologies will be required

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Conclusion

- Grid reliability is being challenged by the needs of a digital society
- Industry is responding aggressively
- EPRI's Reliability and CEIDS initiatives focus developing a national response
- By the way: Don't forget the direct linkage of:
  - Automated maintenance practices to reliability
  - Disaster planning and disaster recovery to reliability and customer relations

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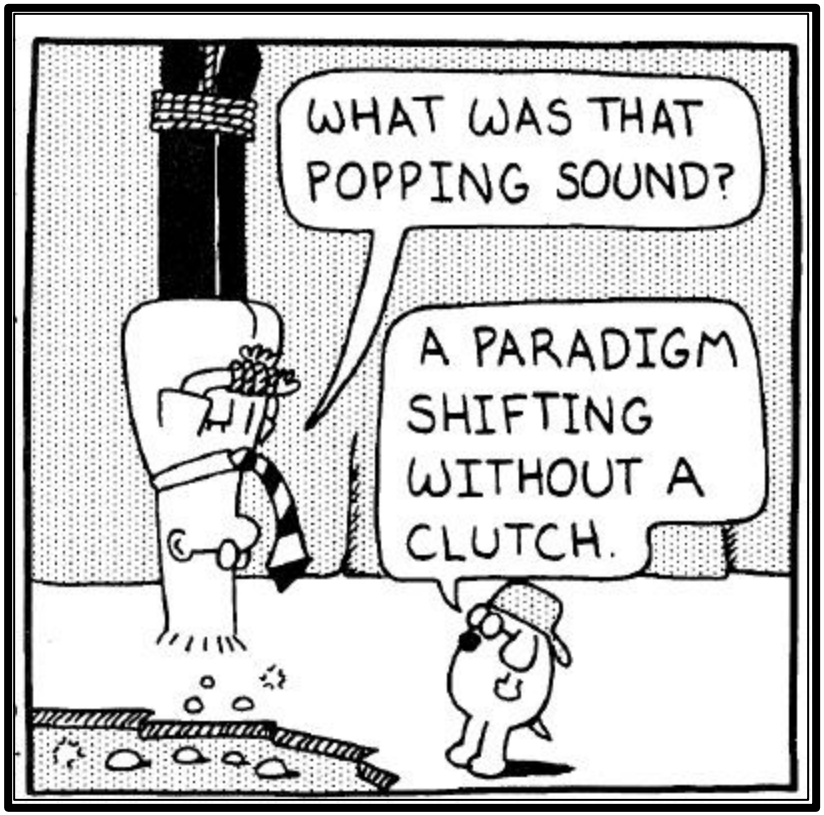
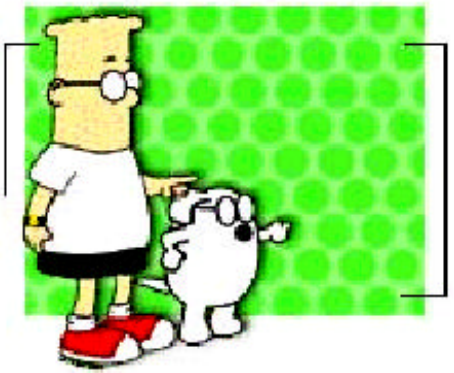
Our Industry Is Changing Rapidly & Globally -- Heads Up (and Down)



By Scott Adams



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