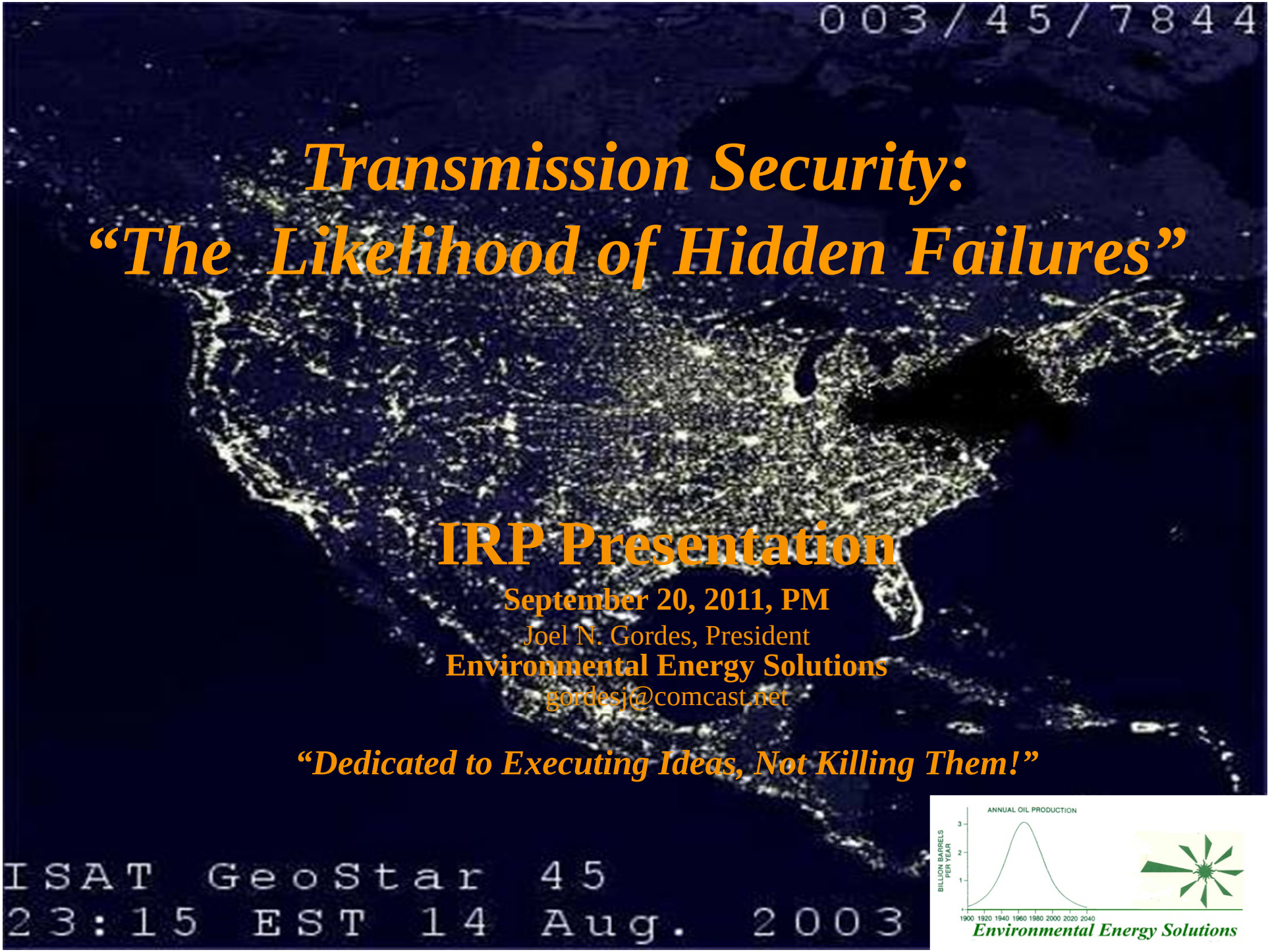


Transmission Security: "The Likelihood of Hidden Failures"

IRP Presentation

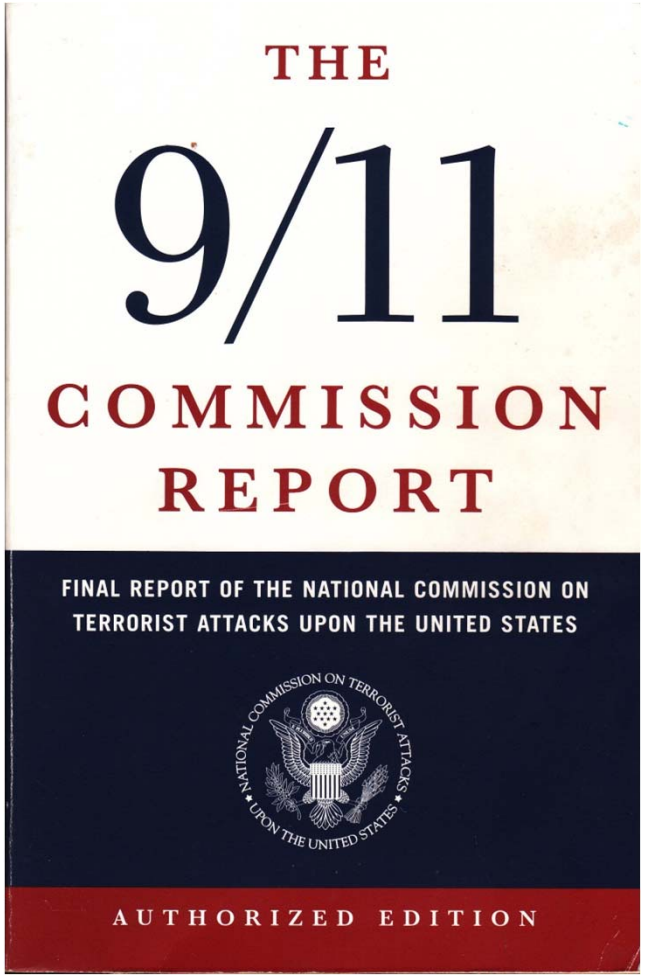
September 20, 2011, PM

Joel N. Gordes, President
Environmental Energy Solutions
gordesj@comcast.net

"Dedicated to Executing Ideas, Not Killing Them!"

Environmental Energy Solutions

It's Ten Years After 9/11
What Have We Learned?



"We believe the 9/11 attacks revealed four kinds of failures; in imagination, policy, capabilities, and management." p.-339

The 9/11 Commission Report
Final Report of the National Commission on Terrorist Attacks Upon the United States
Thomas H. Kean, Chair
Lee H. Hamilton, Vice-Chair
July 22, 2004

It May Take More than Duct Tape & Plastic
Paul West of Winchester, CT

What I Would Like to Convey

Electricity is Essential to All Other Infrastructure

The Grid is a Complex System Subject to Stress

The Grid Is Vulnerable to Natural Hazards

The Grid Is Vulnerable to Physical & Cyber Attacks

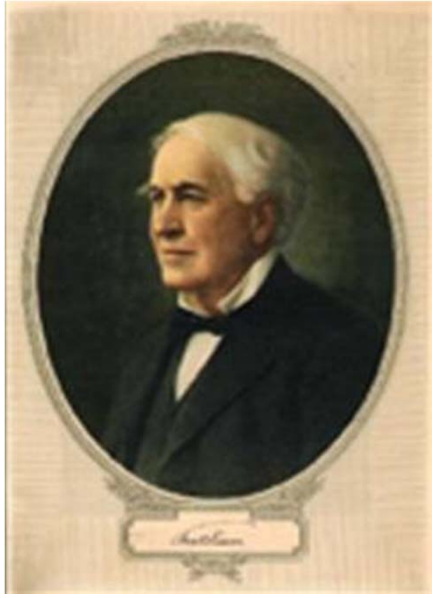
What Is and Is Not “Distributed Generation” (DG)

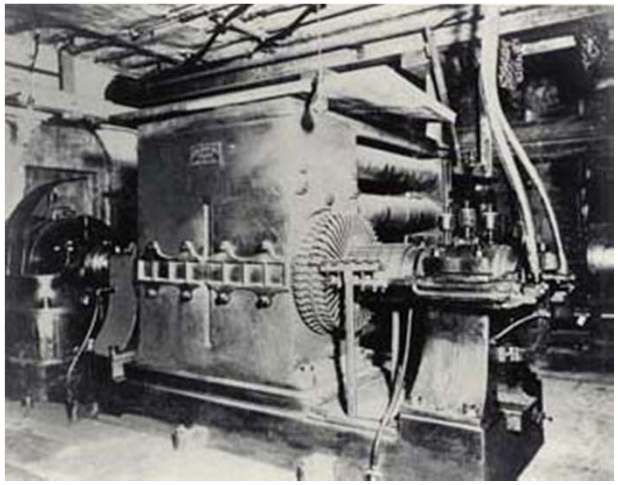
“Decentralization” Vs. DG: How It May Be Helpful

What is The Smart Grid and It’s Challenges

We Began With "MicroGrids"

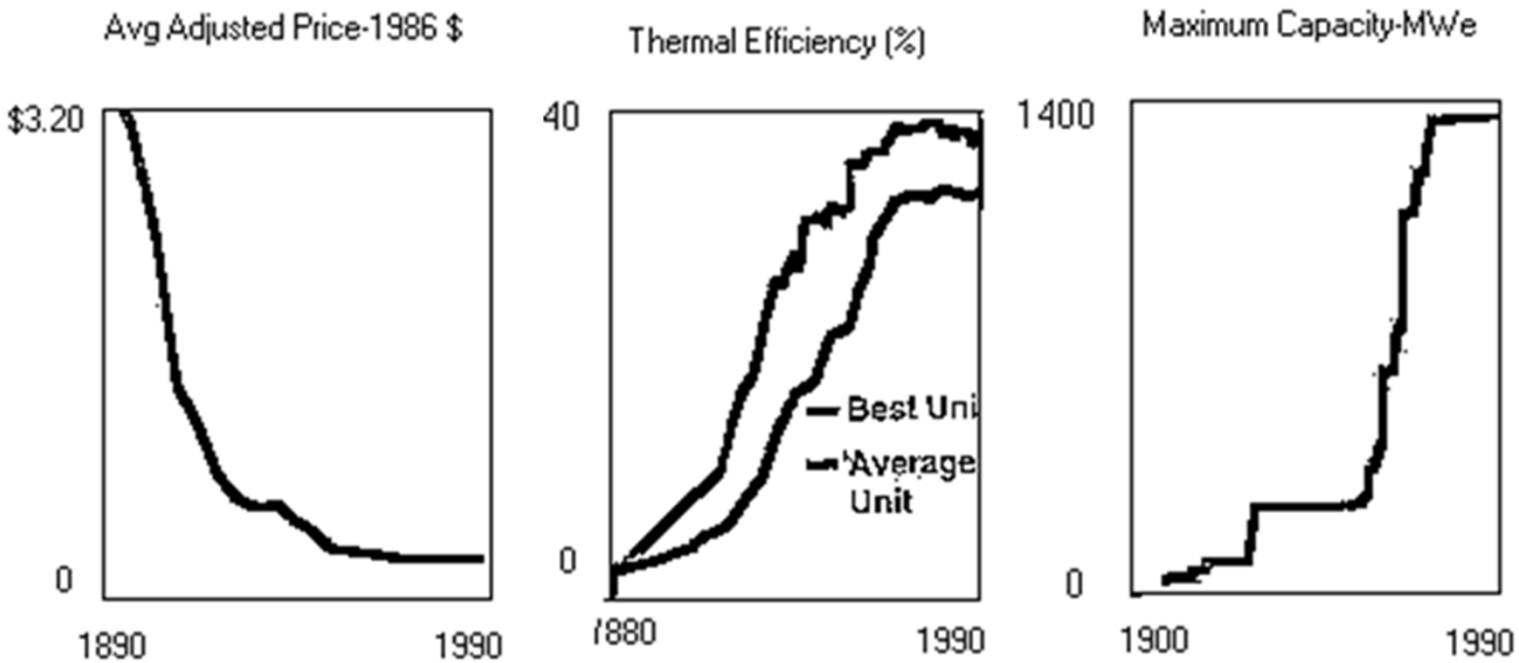
"…microgrids are power systems in which generation elements are co-located with loads, regardless of the aggregated generation capacity or the grid interconnection."





Z. Ye, R. Walling, N. Miller, P. Du, K. Nelson. *Facility Microgrids.* NREL. May 2005.

BUT Early "Microgrids" Had Some Major Drawbacks And Gave Way to Centralized Monopolies



Hint: It Wasn't JUST the Wires

Prof. Richard F. Hirsh, *Technology and Transformation in the American Electric Utility Industry* (Cambridge University Press, 1989)

The Regulated Monopoly Resulted In

- Larger, more efficient generators
- More remote locations for generators
- Need for transmission
- Lower cost for consumers=“Freedom”
- Industrial growth of goods and services
- Greater profits for utilities
- Obvious and hidden vulnerabilities due to transmission that sets the grid architecture

On Security

"**Security** has always been a **priority** for the electricity sector in North America; however, it is a greater priority now than ever before."

U.S.-Canada Power System Outage Task Force
August 14th Blackout: Causes and Recommendations
Chapter 9, *Physical and Cyber Security Aspects of the Blackout*
p. 133

It is Implied There Is Some Disagreement on This Point

See EPRI on Slides 50 and 59

So, What Are the Energy Security Threats?

As Opposed to RAM, Sufficiency, etc.?

- **Fuel supply interruption/cost escalation**

- **Physical security of generation, transmission, distribution , SCADA**

- **Foreign dependency via disruption of globalized supply chains for critical grid components (e.g. GSUs) and minerals used in component manufacturing processes**

- **Cyberthreats including distributed denial of service, hacking, electromagnetic pulse, embedded codes in foreign sourced components and weaknesses in SCADA/IPC**

- **A combined or "blended" combination of the aforementioned threats**

- **Other threats and considerations including “unintended consequences”**

TRANSMITTING THE FACTS

Why southwest Connecticut needs an upgraded transmission system.

Over the last 20 years, energy consumption in southwest Connecticut has increased 50%. Although CL&P has made numerous improvements to the transmission system, an upgrade is needed to meet growing demand.

Experts agree on the need for an upgrade. The Independent System Operator of New England (ISO-NE) and the Connecticut Department of Public Utility Control (DPUC) have declared the existing transmission system one of the most congested in the country. The Federal Energy Regulatory Commission (FERC) ranked southwest Connecticut one of the nation's top 10 energy reliability risks.

345-kV offers the most environmentally friendly, cheapest and most reliable energy future. 345-kv lines have less environmental impact than lower-voltage solutions, which require wider right of ways. With 345-kV lines, homeowners will have access to the lowest priced energy available, and businesses can look to Connecticut as a location with a reliable supply of competitively priced energy.

Southwest Connecticut has the highest energy consumption in the state. Our proposed upgrades will correct the existing system congestion and increase capacity to meet a 30-year growth forecast – as well as a full range of standard emergency contingencies. It's the best way to assure adequate access to energy for the people and businesses of southwest Connecticut.

For more information, visit http://transmission.nu.com. We look forward to your feedback.

Connecticut Light & Power

The Northeast Utilities System

Delivering the Energy of Connecticut

Paid for by Northeast Utilities shareholders.

9/11/03

It's amazing how much you can see when the lights go out.

The recent North American blackout made it abundantly clear just how much we rely on electricity; not simply to light our way or cook our food, but to maintain a robust economy.

We live in an increasingly digital world in which vast amounts of data are sent electronically, in real time, from business to business and person to person. An interruption in the flow means a disruption in commerce, communication and community.

The world of energy is changing, and so is CL&P.

We're positioning ourselves as a top performer by continuously adopting best business practices from within and outside our industry. We're more agile and more responsive. You can see it in our continuous improvement ethic and in our strategic, long-term investment planning.

And while our business practices have modernized, the electric delivery system has a long way to go. It was built in the 1960s and 1970s to accommodate the technologies and the demands of the time. Although CL&P has made numerous improvements over the years, the infrastructure is not sufficient to meet the needs and demands of the 21st century.

As the "digitalization" of our world expands, so does CL&P's commitment to delivering reliable, high-quality power to all our customers. Watch this space in the coming weeks, and we'll explain how.

Connecticut Light & Power

The Northeast Utilities System
cl-p.com

Energy for a Changing World™

This ad paid for by NU shareholders.

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NEEWS

Greater Springfield Reliability Project

Learn More about Construction of the Greater Springfield Reliability Project

The Greater Springfield Reliability Project is a 39-mile transmission upgrade project that will improve electric reliability in southern New England. The route follows existing utility rights-of-way through Bloomfield, East Granby and Suffield, Connecticut and continues into Agawam, West Springfield, Chicopee, Springfield and Ludlow, Massachusetts.

Please join us at CL&P's Construction Open House to learn more about the construction process in your area. Project representatives will be on hand to discuss construction activities and respond to questions or concerns you may have about the process.

You are invited to attend one of our Construction Open House sessions to learn more:

Tues., September 20, 2011
6-8 p.m.
East Granby High School Auditorium
95 South Main Street
East Granby, CT 06026

Wed., September 21, 2011
6-8 p.m.
Suffield High School Common Room
1060 Sheldon Street
West Suffield, CT 06093

For more information, visit www.NEEWSprojects.com or call 1-866-99-NEEWS/888-773-5384 (Se habla español).

Connecticut Light & Power
A Northeast Utilities Company

Hartford Courant Ad of 9-15-11

UTILITIES

Lines Spark Debate

Attorney General, Regulators Oppose Charging Ratepayers

By JANICE PODSADA
jpodsada@courant.com

Attorney General George Jepsen and state regulators are challenging a federal policy that allows utilities to collect multimillion-dollar "incentives" — at the expense of utility ratepayers — to build high-voltage electric transmission lines.

Jepsen called the incentives "overpriced, unnecessary and an unfair burden on consumers," but Northeast Utilities defended the payments, saying they save ratepayers money in the long run.

The Federal Energy Regulatory Commission maintains the policy as a way to ensure that the transmission system, which carries electricity from generation plants to switching stations, is reliable and efficient. Utilities, including Connecticut Light & Power and United Illuminating in Connecticut, are allowed to tack some of the costs onto ratepayers' bills.

"The incentives are applied on top of what's already built into the rates," said Susan Kinsman, a spokeswoman for the attorney general's office.

The debate is complex because if the incentives add grid reliability, that could lower other costs incurred by ratepayers. But Jepsen said in a 65-page filing with FERC this week that the utilities might not need the incentives.

"In recent years, New England has led the way in its commitment to investing in new transmission facilities," Jepsen wrote. But he added that sometimes "the inducements were probably unnecessary and therefore wasteful."

The incentives were established by Congress as part of the 2005 Energy Policy Act, partly in response to the blackout that occurred in the Northeast in 2003.

"The incentives have worked well, increasing the grid's reliability and reducing ratepayer charges," said Frank Poirot, a spokesman for Northeast Utilities, the parent company of Connecticut Light & Power.

"In New England all the utilities have invested about $4 billion in new regional transmission equipment that has increased reliability and reduced congestion charges by about $400 million."

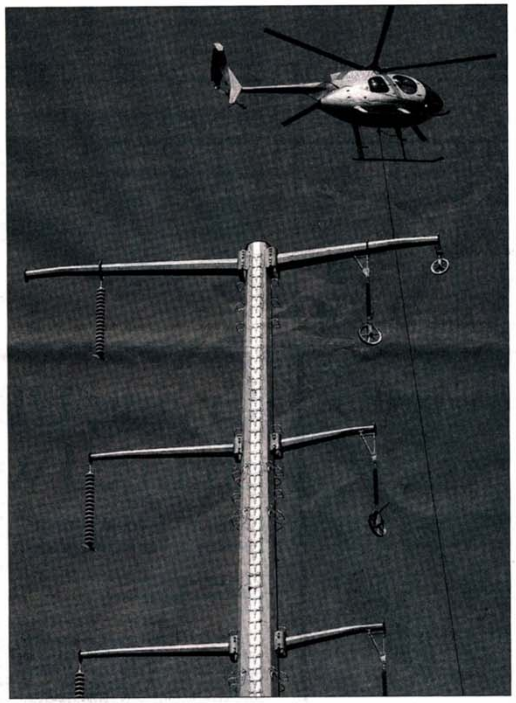
Eliminating those incentives could make it more difficult to finance major transmission projects, Poirot said.

"We have to go to large financial institutions to finance these projects and spread those costs out like a mortgage over the years," he said. "With incentives in place, it holds down the costs of these projects, ultimately reducing costs to customers."

Jepsen's challenge is endorsed by the Connecticut Office of Consumer Counsel, attorneys general in Massachusetts, Rhode Island, New Hampshire, Delaware and Illinois and utility regulatory commissions in all six New England states, along with consumer representatives and municipal utilities and Connecticut's congressional delegation, which sent a letter of support.

The challenge is a response to FERC's request for public comments.

"Under the current rules, too many projects that do not deserve incentive rate awards receive them," said Kevin DelGobbo, chairman of the Public Utilities Regulatory Authority. "The rules for awarding incentive rates should be more goal-specific and more narrowly tailored to projects that meet specific criteria — such as ... projects that use improved and innovative technologies, and projects that will provide substantial economic, electricity reliability and other benefits to consumers." 9/17/11

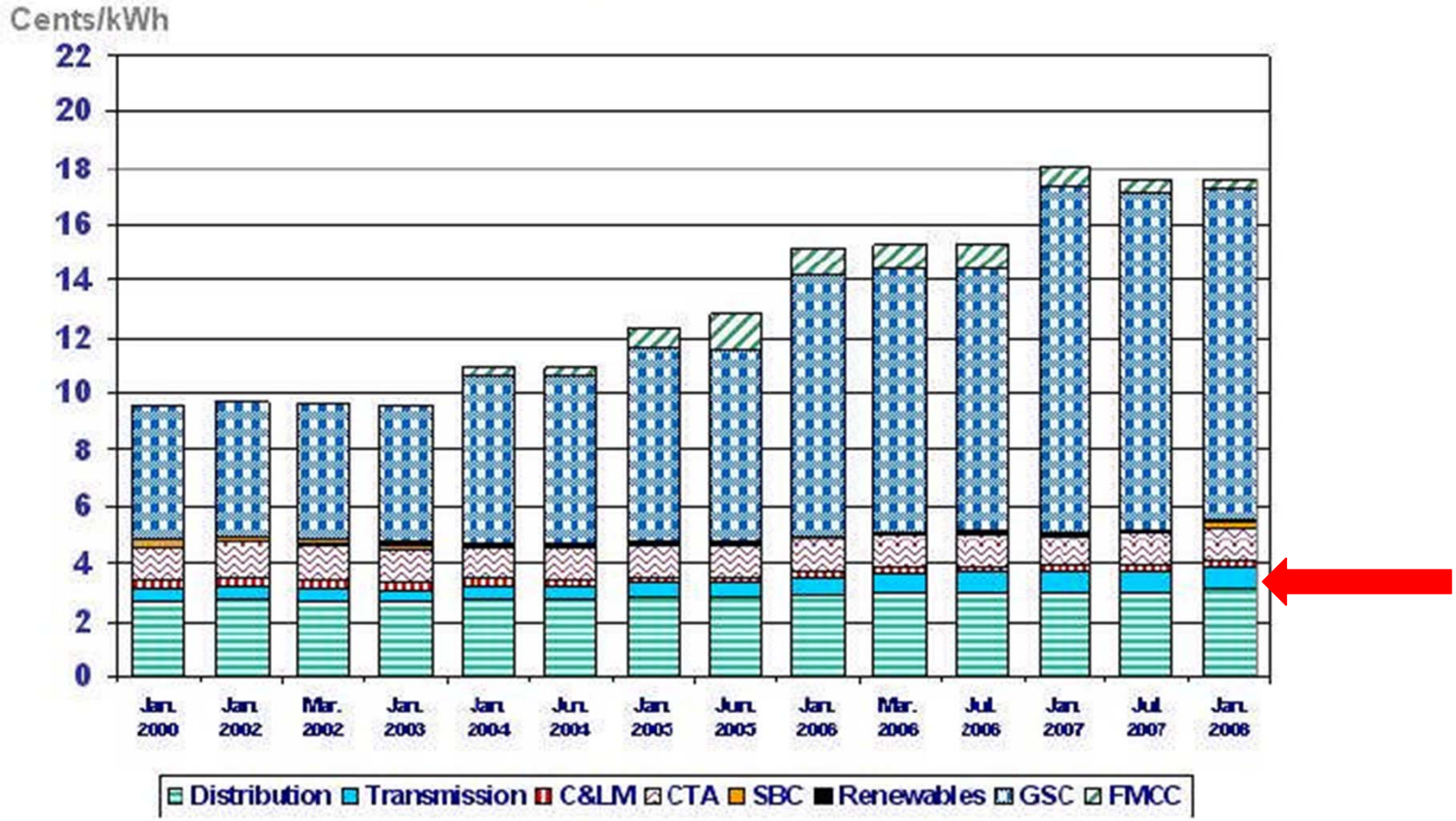


CLOE POISSON/CPOISSON@COURANT.COM

A HELICOPTER STRINGS high-tension power lines over a new 175-foot steel monopole off Valley View Road in Wallingford as part of a Northeast Utilities Middletown-Norwalk Transmission Project to resolve a transmission system bottleneck in southwest Connecticut.

Hartford Courant Article of 9-17-11

CL&P & UI Average Electric Rates, 2000 - 2008



Blakey, Bruce. The Cost of Electricity: An Analysis of the Components and Drivers of Electricity Costs in Connecticut. ECMB. May 2008.

Grid Congestion Has Been a National Problem

“Americans' demand for electricity is growing at almost two percent per year. But our power grid is expanding at only half that rate.”

The Current Recession Has Provided Some Respite From the High Growth Rates But Growth In Many Electronic Technologies Will Further Stress the Grid

Charlotte Legates, Energy.com, March 2, 1999

Congestion Can be Costly in a Digital Society

Industry	*Average Downtime $*
➢ **Cellular Communications**	**$41,000 per hour**
➢ **Airline Reservations**	**$90,000 per hour**
➢ **Credit Card Operations**	**$2,580,000 per hour**
➢ **Brokerage Operations**	**$6,480,000 per hour**
➢ **Average Small Business**	**$7,500 per day**

National Academies Report on Countering Terrorism

"A direct way to address vulnerable transmission bottlenecks and make the grid more robust is to build additional transmission capacity, but there are indications that **redundancy has a dark side**... **The likelihood of hidden failures in any large-scale system** increases as the number of components increases."

Making the Nation Safer: The Role of Science and Technology in Countering Terrorism. National Academy Press. p.302. June 2002.

The Grid is Vulnerable

Early (2-20-83) Actual Vulnerability Signs

"Insurance Capitol of the World"--(Crow-1, Hartford-0)

Crow Short-Circuits Phones, Power

By BRADLEY STERTZ
Courant Staff Writer

It was business as usual Saturday morning in downtown Hartford — until the crow struck.

Within a few seconds, the crow neatly cut large swaths in the city's phone service, threw thousands of people into the dark and left computer operators at dozens of the city's largest companies scrambling to preserve precious data.

All this because the crow had perched on the wrong power line.

A little after 11:30 a.m., the crow landed on an uninsulated Northeast Utilities circuit breaker at the South Meadow substation in Hartford. This short-circuited a couple of power lines for about two seconds and damaged six insulators, electric company spokesman Michael J. London said.

The drop in power traveled down the line, and rooms throughout the city went dark as lights popped off and on again in an instant.

For most, that is all that happened. For others, the crow's landing caused much greater problems.

At the Civic Center, thousands were assembling for the University of Connecticut-Villanova University basketball game, when half the building's lights went out. The blackout, mainly confined to stores on the north side of the building, lasted more than an hour. Power was restored by game time, Civic Center security officials said, but not before most of the north side stores had lost thousands of dollars in business.

At Southern New England Telephone, an electrical failure put an unknown number of phones thoughout Hartford out of service for more than an hour, a company spokesman said.

At several downtown companies, computer systems shut down and it will cost thousands of dollars to retrieve from oblivion information that was being fed into the data-processing machines. The Travelers Cos. was forced to go into an emergency data-recovery exercise that had not been attempted in recent memory, explained Travelers senior Vice President Peter Libassi. It took Travelers four hours after the crow landed to get the computers under control.

"Sometimes, you have to wonder just how advanced technology is when something like this can cause these problems with this kind of equipment," Libassi said. "We'll eventually be able to recover everything, but we're lucky this didn't happen on a weekday, when hundreds of our field offices across the country would have had to shut down. Potentially, something like this could have really cost the company a lot of money."

Shop owners also lost a substantial amount of money from the electrical blip. Especially hard hit were those stores in the Civic Center that had to close when the building blacked out.

"We lost all of our UConn basketball business, which I'd say is half a day's sales on our busiest day," said Fred Basil, manager of Liquor Merchants Ltd. in the Civ-

See Errant, Page A9

Errant Crow Casts Brief Pall Over City

Continued from Page 1

ic Center. "We expected this to be a big day, what with 16,000 people coming in here. Instead, we had to sit tight and close our doors for safety."

Civic Center security warned shopkeepers to close, fearing a rash of shoplifting with the large crowd descending on the dark stores.

"We had to close all but one of our doors, and then only let in customers who specifically had something to buy," Leigh Ferguson, shopkeeper at Koenig Art Emporium, said. "During the hour's time the lights were out we had three customers. On a normal day we would have had more than a hundred browsers in the same period of time. I know we lost money."

Power also went out at other four buildings. At the Hartford Square West housing complex and an office building on South Washington Street power was lost for a half hour. An auto body shop and a laundry on the 100 block of Charter Oak Avenue also lost power.

And there was one fatality the crow.

The Grid is Still Vulnerable

25 Years Later, Son of Crow Strikes!

"Insurance Capitol of the World"--(Crow-2, Hartford-0)

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March 3, 2008

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STATE BRIEFS

Crow Causes Power Surge

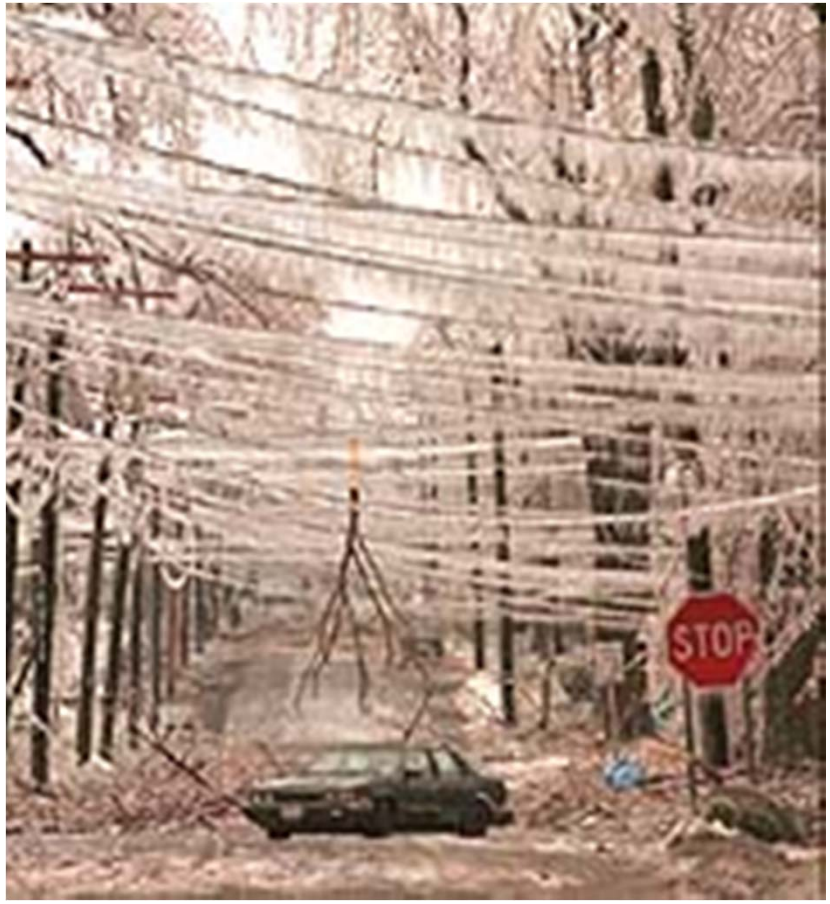
March 3, 2008

HARTFORD — - A crow flew into an electrical substation in South Meadows on Sunday afternoon, triggering a power surge that affected about 270 buildings in parts of downtown and the South End, Connecticut Light & Power officials said.

The surge, reported about 1:25 p.m., briefly cut power, set off a chorus of fire and burglar alarms and stopped at least one elevator in its tracks. Back-up generators kicked on at Hartford Hospital, the Convention Center and several other large buildings, CL&P officials said. Hartford Hospital spokeswoman Lee Monroe said the system returned to normal in about a minute.

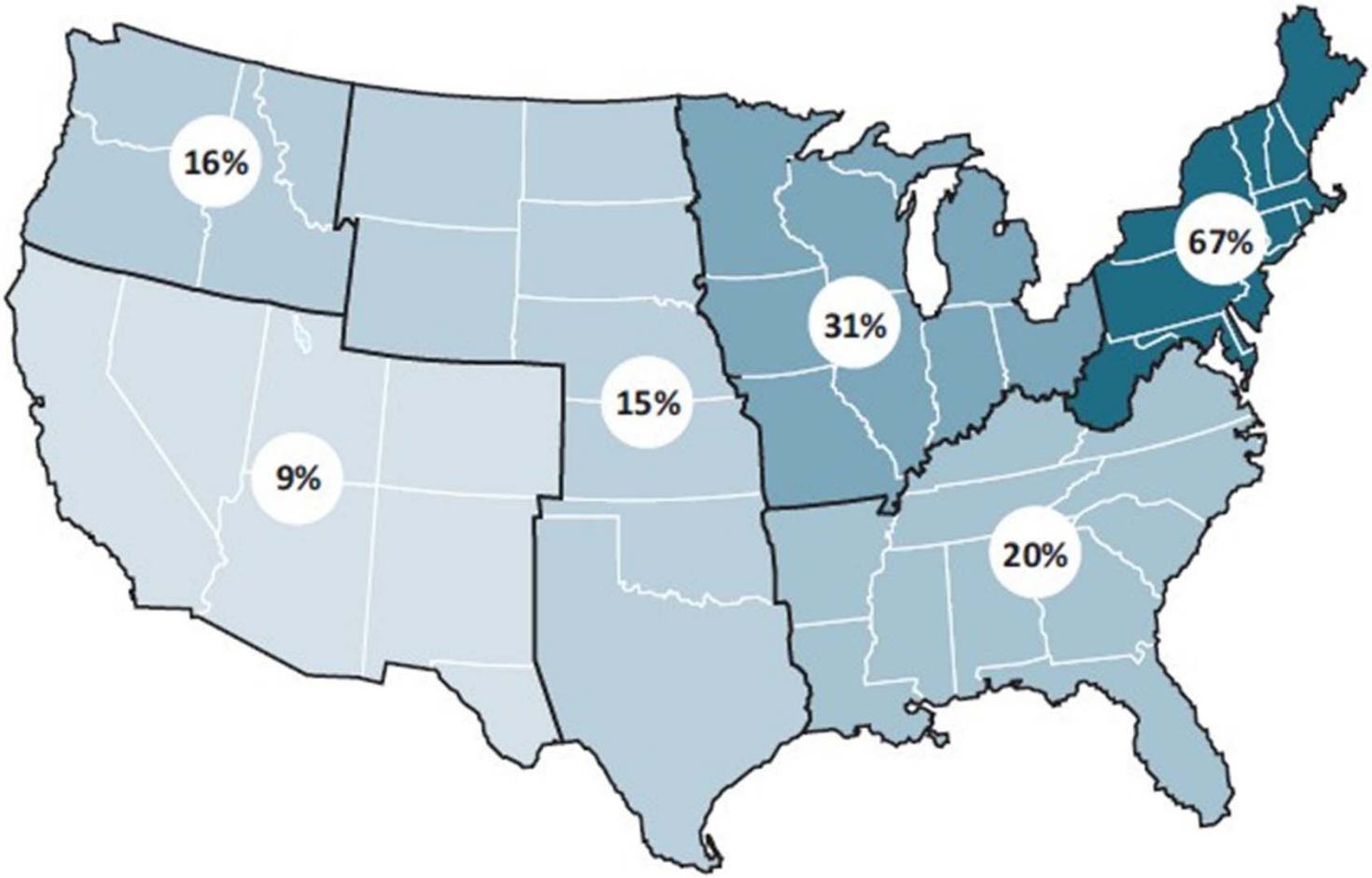
However, power was still out at the XL Center several hours after the surge, said CL&P spokesman Al Lara. He said crews restored electricity to the arena by 5:30 p.m. There were no events scheduled at the XL Center Sunday afternoon or night, police said.

Be it Congestion, Natural Disaster or Terror the Results Can Be Similar



$1.2 Billion Losses US and Canada-1998

Figure A5: Increased frequency of heavy precipitation in the contiguous United States from 1958 to 2007.

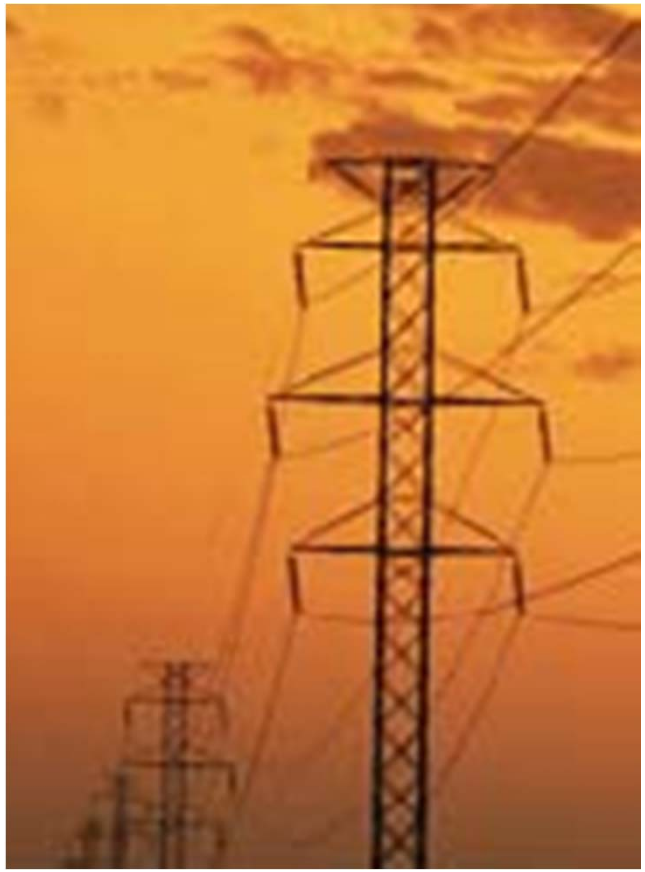


Electric Grid Components are Vulnerable to Physical Damage at Multiple Points

Cyberattacks: Not by Nature Alone

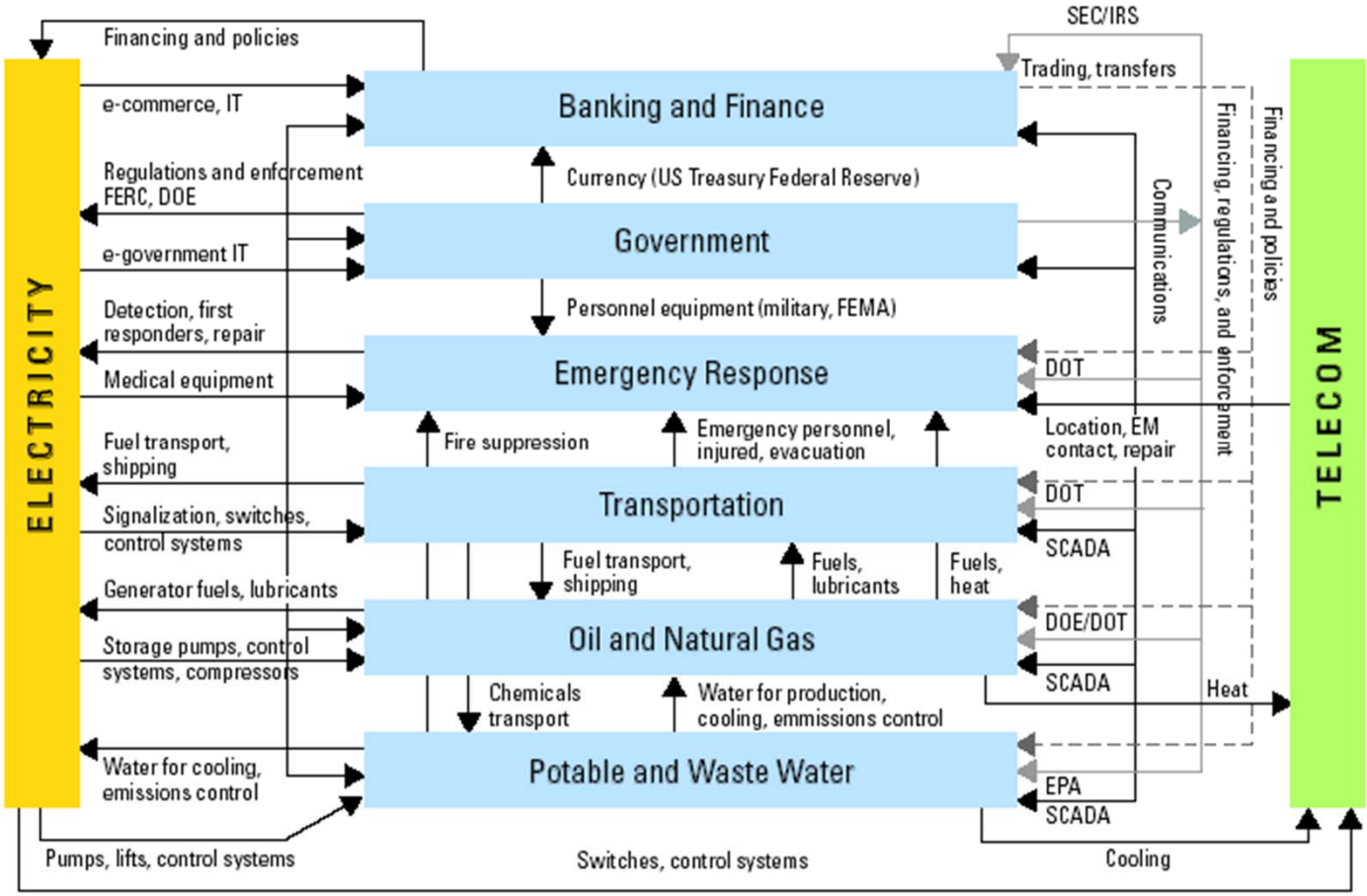
Electric Grid Vulnerability is Modern Society's Soft Underbelly

Modern societies are composed of four critical, highly interrelated, and symbiotic infrastructures upon which their national and personal survival depends: *The power grid is the foundation of it all*.

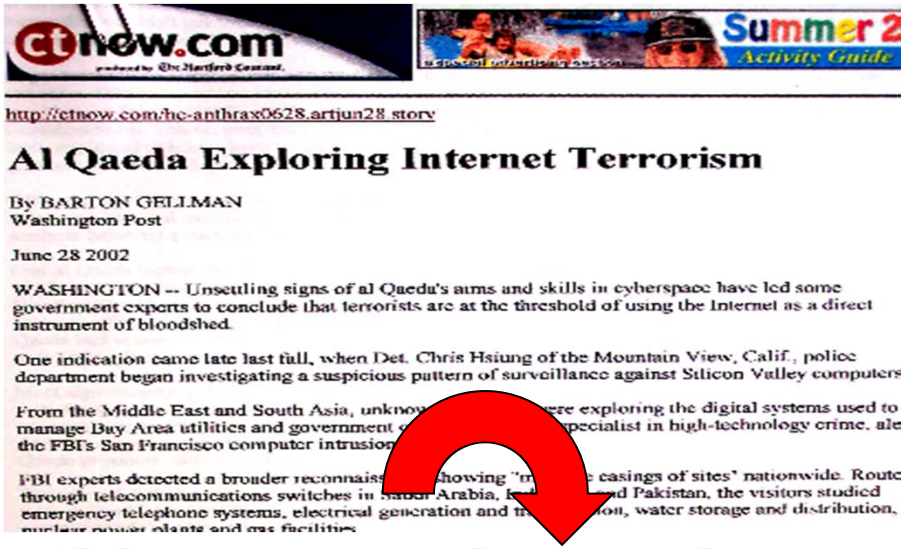


Winn Schwartau, *Information Warfare, Electronic Civil Defense*, Thunders Mouth Press, New York, 1996. p. 43.

National Academies Report



Making the Nation Safer: The Role of Science and Technology in Countering Terrorism. National Academy Press. June 2002.



ctnow.com

http://ctnow.com/hc-anthrax0628.artjun28.story

Al Qaeda Exploring Internet Terrorism

By BARTON GELLMAN
Washington Post

June 28 2002

WASHINGTON -- Unsettling signs of al Qaeda's aims and skills in cyberspace have led some government experts to conclude that terrorists are at the threshold of using the Internet as a direct instrument of bloodshed.

One indication came late last fall, when Det. Chris Hsiung of the Mountain View, Calif., police department began investigating a suspicious pattern of surveillance against Silicon Valley computers

From the Middle East and South Asia, unkno[illegible]re exploring the digital systems used to manage Bay Area utilities and government [illegible]pecialist in high-technology crime, ale[illegible] the FBI's San Francisco computer intrusion[illegible]

FBI experts detected a broader reconnais[illegible]howing "m[illegible]e casings of sites" nationwide. Route through telecommunications switches in [illegible] Arabia, [illegible]d Pakistan, the visitors studied emergency telephone systems, electrical generation and t[illegible]ion, water storage and distribution, nuclear power plants and gas facilities

Sheikh Omar Bakri Muhammad

bin Laden Associate

"In a matter of time you will see attacks on the stock market…I would not be surprised if tomorrow I hear of a big economic collapse because of somebody attacking the main technical systems in big companies….

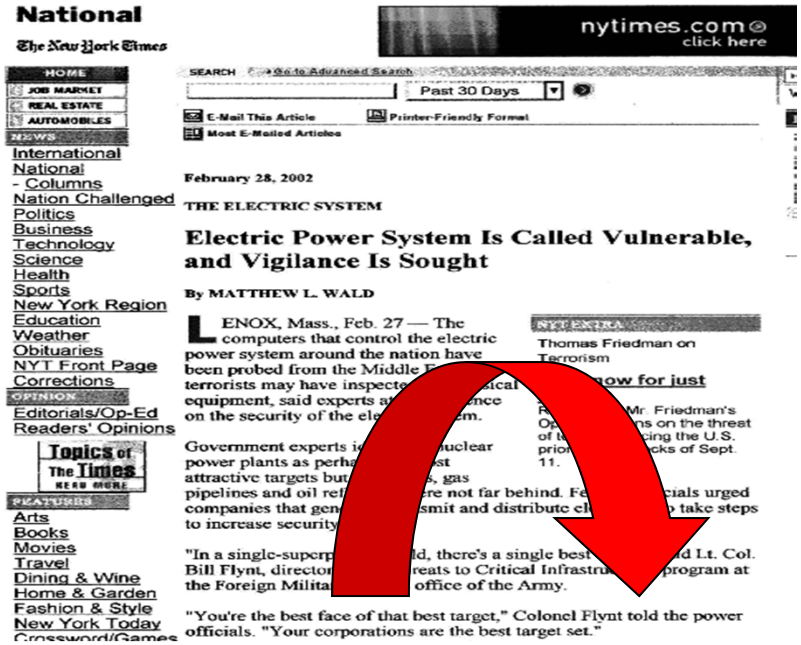
ComputerWorld.com
Nov 18, 2002.

Forms of CyberWar#1
Computer Hacking to Disrupt the Grid

It Would Be Hubris to Think the Electric Grid Could Not Be Compromised

Lockheed Martin	CIA
Google	ADP
Citigroup	MSNBC
Sony	IMF
Pentagon	ExxonMobile

The Centralized Power Industry is a Prime Target



National

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February 28, 2002

THE ELECTRIC SYSTEM

Electric Power System Is Called Vulnerable, and Vigilance Is Sought

By MATTHEW L. WALD

LENOX, Mass., Feb. 27 — The computers that control the electric power system around the nation have been probed from the Middle E terrorists may have inspecte equipment, said experts a on the security of the el

Government experts i power plants as perha attractive targets but pipelines and oil ref companies that gen to increase security

"In a single-superp Bill Flynt, director the Foreign Milita

"You're the best face of that best target," Colonel Flynt told the power officials. "Your corporations are the best target set."

NYT EXTRA
Thomas Friedman on Terrorism
now for just

"In a single-superpower world, there's a single best target…You're the best face of that best target…Your corporations [power companies] are the best target set."-Lt. Col. Wm. Flynt, US Army

Matthew L. Wald. *Electric Power System Is Called Vulnerable, and Vigilance Is Sought.* New York Times. Feb 28. 2002.

Bill Flynt, Ph.D. at ICATHS on 9/25/03

His Red Team was able to take a police officer with basic computer skills and trained him to shut down a regional-sized area within 9 minutes and 40 seconds.

Bill Flynt, Ph.D. on 9/25/03 at ICATHS

- [It is] “trivial to achieve significant consequences”
- Looked at inflicting a multi-state, 168 hour event
- Potentially 1 year to 18 months until fully repaired
- “effects cascade and cross infrastructural boundaries”

washingtonpost.com

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Hackers Have Attacked Foreign Utilities, CIA Analyst Says

By Ellen Nakashima and Steven Mufson
Washington Post Staff Writers and Washington Post Staff Writers
Saturday, January 19, 2008; Page A04

In a rare public warning to the power and utility industry, a CIA analyst this week said cyber attackers have hacked into the computer systems of utility companies outside the United States and made demands, in at least one case causing a power outage that affected multiple cities.

"We do not know who executed these attacks or why, but all involved intrusions through the Internet," Tom Donahue, the CIA's top cybersecurity analyst, said Wednesday at a trade conference in New Orleans.

Donahue's comments were "designed to highlight to the audience the challenges posed by potential cyber intrusions," CIA spokesman George Little said. The audience was made up of 300 U.S. and international security officials from the government and from electric, water, oil and gas companies, including BP, Chevron and the Southern Co.

Aurora Project Destroyed a Generator Via Hacking a Test "Grid" at Idaho National Labs in 2007

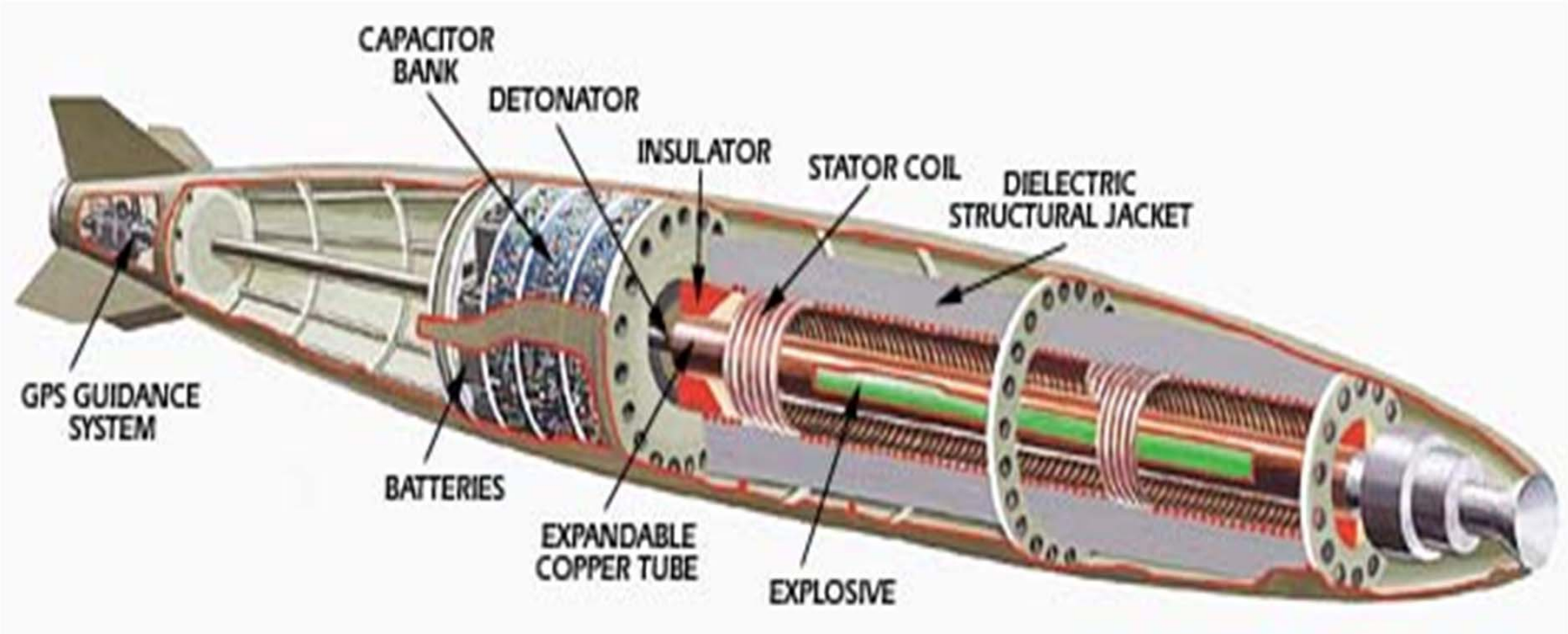
Courtesy of CNN http://www.youtube.com/watch?v=rTkXgqK1l9A

The Threat Could Reside Anywhere BUT Attribution Questions Limit Retaliation

Forms of CyberWar #2

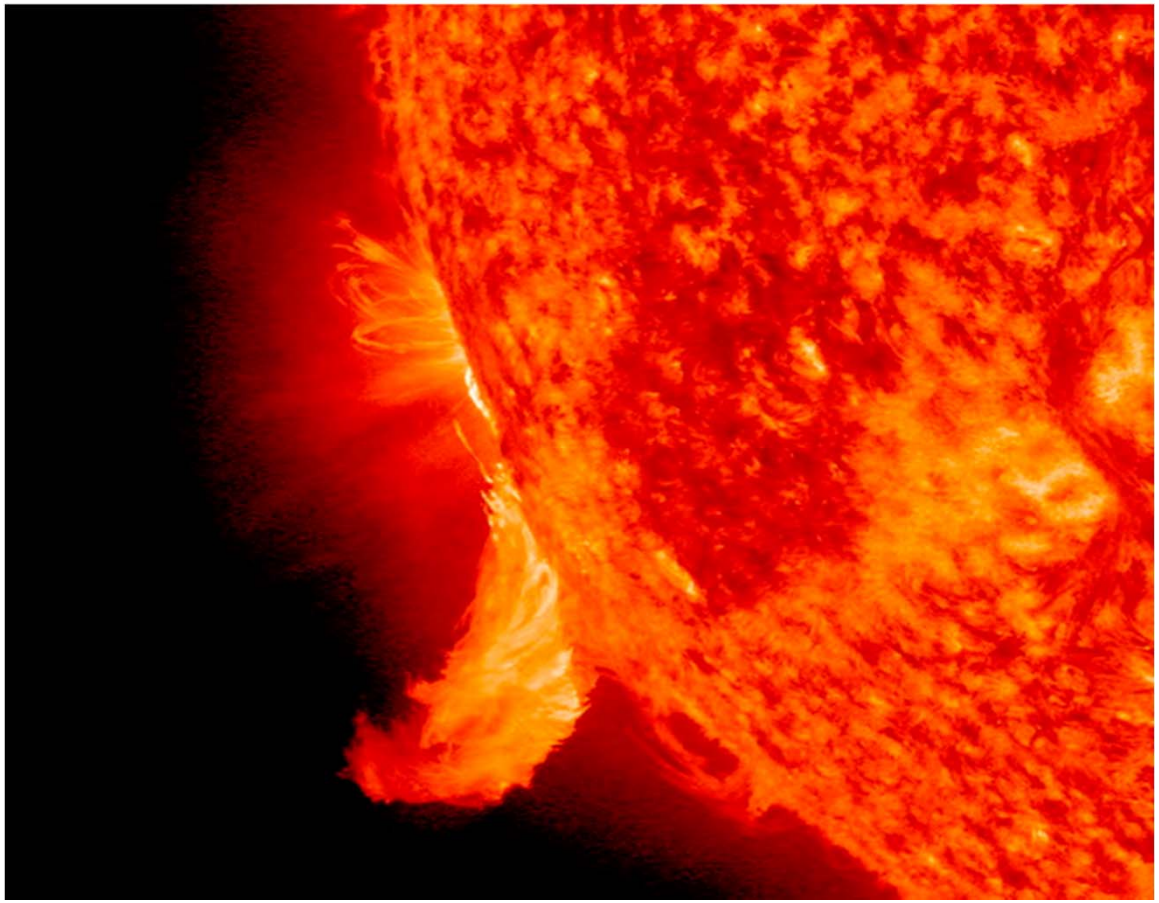
Electromagnetic Pulse (EMP)

Uses a Nuclear Device or Low Tech FCG



Low Probability/High Risk BUT…
Essentially You Are Back to the Stone Age

“Our Friend the Sun”



Nature's Own Electromagnetic Pulse (EMP) (Coronal Mass Ejection – 1989 Canada)

Solar Flare Disrupts GPS Gear

By MARC KAUFMAN
WASHINGTON POST
4/8/07

WASHINGTON — Global positioning system devices around the world were briefly but significantly disrupted late last year by an unexpectedly large blast of radio waves during a solar flare, researchers reported at a conference last week.

The Dec. 6 solar flare spawned an intense burst of radio wave radiation, including some at the same frequencies used by GPS hardware — creating a "noise" that made it impossible for many receivers to continue receiving signals from GPS satellites. The effect, said Cornell University Professor Paul Kintner, was "more profound and widespread than we thought possible."

The event was considered especially worrisome because it occurred during a "solar minimum," part of an 11-year cycle when sunspots and solar flares are least frequent. When the next "solar maximum" arrives around 2011, researchers said, the disruptions to GPS devices and other satellite-based navigation instruments could be far more severe.

"This radio event was 10 to 20 times bigger than anything we had measured before, or thought would reach Earth from the sun," said William Murtagh of the National Oceanic and Atmospheric Administration's Space Environment Center, an organizer of the Washington conference on the field of space weather.

"It told us that when it comes to preparing for big solar events, we can never let down our guard," Murtagh said. "We really don't know what might be coming."

The impact of the December disruption on transportation and other systems remains unclear, in part because military and commercial GPS users do not like to discuss their vulnerabilities. But the researchers said many receivers were useless for 10 minutes, and some for longer periods.

GPS is widely used in navigation, surveying, siting sensitive equipment such as deep-sea oil rigs and military operations of all kinds, as well as in organizing the flow of electricity through power grids and in international financial transactions. Its use is growing quickly without much awareness of its vulnerability, several space-weather researchers said.

Scientists have known for some time that GPS, which relies on receiving precisely timed radio signals from several of 24 orbiting satellites, can be disrupted by electromagnetic storms created in Earth's ionosphere by solar flares and eruptions. A major electromagnetic storm at the end of October 2003 had some GPS units down for up to 19 hours.

Forms of CyberWar #3

U.S. Caused Soviet Gas Explosion

By DAVID E. HOFFMAN
WASHINGTON POST
2/27/04

WASHINGTON — In January 1982, President Reagan approved a CIA plan to sabotage the economy of the Soviet Union through secret transfers of technology that contained hidden malfunctions, including software that later triggered a huge explosion in a Siberian natural gas pipeline, according to a new memoir by a Reagan White House official.

Thomas C. Reed, a former Air Force secretary who was serving in the National Security Council at the time, describes the episode in "At the Abyss: An Insider's History of the Cold War," to be published next month by Ballantine Books.

Reed writes that the pipeline explosion was just one example of "cold-eyed economic warfare" against the Soviet Union that the CIA carried out under Director William J. Casey during the final years of the Cold War.

At the time, the United States was attempting to block Western Europe from importing Soviet natural gas. There were also signs that the Soviets were trying to steal a wide variety of Western technology. Then, a KGB insider revealed the specific shopping list and the CIA slipped the flawed software to the Soviets in a way they would not detect it.

"In order to disrupt the Soviet gas supply, its hard currency earnings from the West, and the internal Russian economy, the pipeline software that was to run the pumps, turbines, and valves was programmed to go haywire, after a decent interval, to reset pump speeds and valve settings to produce pressures far beyond those acceptable to pipeline joints and

PLEASE SEE SOVIET, PAGE A14

Forms of CyberWar #3A

Pre-Installed Viruses

Some Tech Gadgets Come Loaded With Unwanted Extra

By JORDAN ROBERTSON
ASSOCIATED PRESS

From iPods to navigation systems, some of today's hottest gadgets are landing on store shelves with some unwanted extras from the factory — pre-installed viruses that steal passwords, open doors for hackers and make computers spew spam.

Computer users have been warned for years about virus threats from downloading Internet porn and opening suspicious e-mail attachments. Now they run the risk of picking up a digital infection just by plugging a new gizmo into their PCs.

Recent cases reviewed by The Associated Press include some of the most widely used tech devices: Apple iPods, digital picture frames sold by Target and Best Buy stores and TomTom navigation gear.

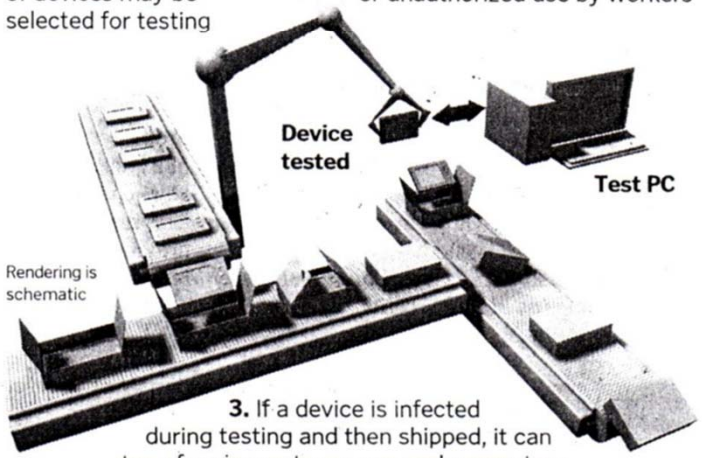
In most cases, Chinese factories — where many companies

Infected, Fresh Out Of The Box

Harmful computer viruses can infiltrate hardware before it leaves the factory. In the recent years, some hard drives, GPS devices, digital picture frames and music players were tainted during the manufacturing process.

1. At the end of an assembly line, a sampling of devices may be selected for testing

2. Test PCs can contract viruses through an Internet connection or unauthorized use by workers



3. If a device is infected during testing and then shipped, it can transfer viruses to consumers' computers

AP

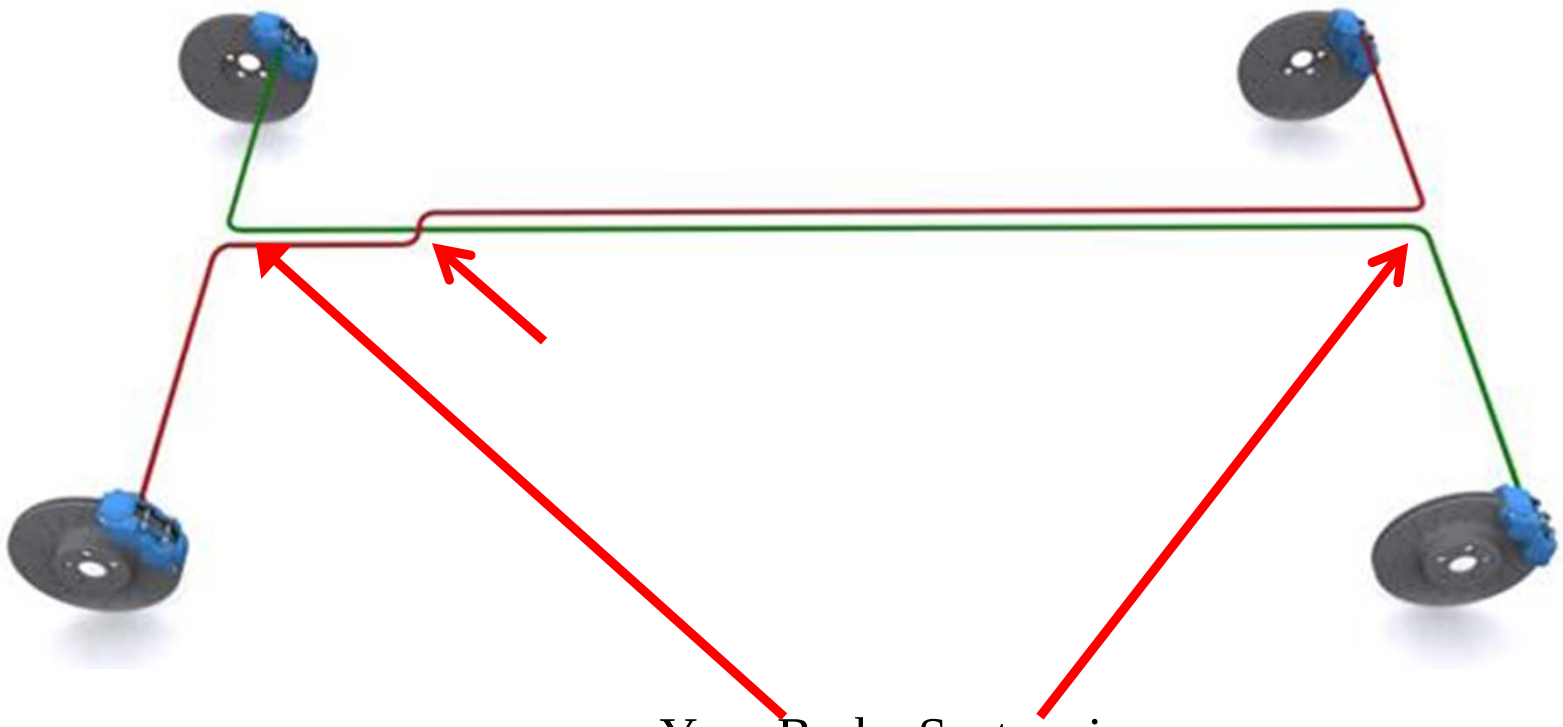
Jordan Robertson, Associated Press. March 14, 2008.

Some Potential Alternate Solutions?
Time-Tested Ecosystems Offer Resiliency Lessons

Nature Loves Redundancy & Diversity

We Need to Mimic Nature

Redundancy Vs. "Decentralized"



Your Brake System is "Redundant" But Not totally "Decentralized"

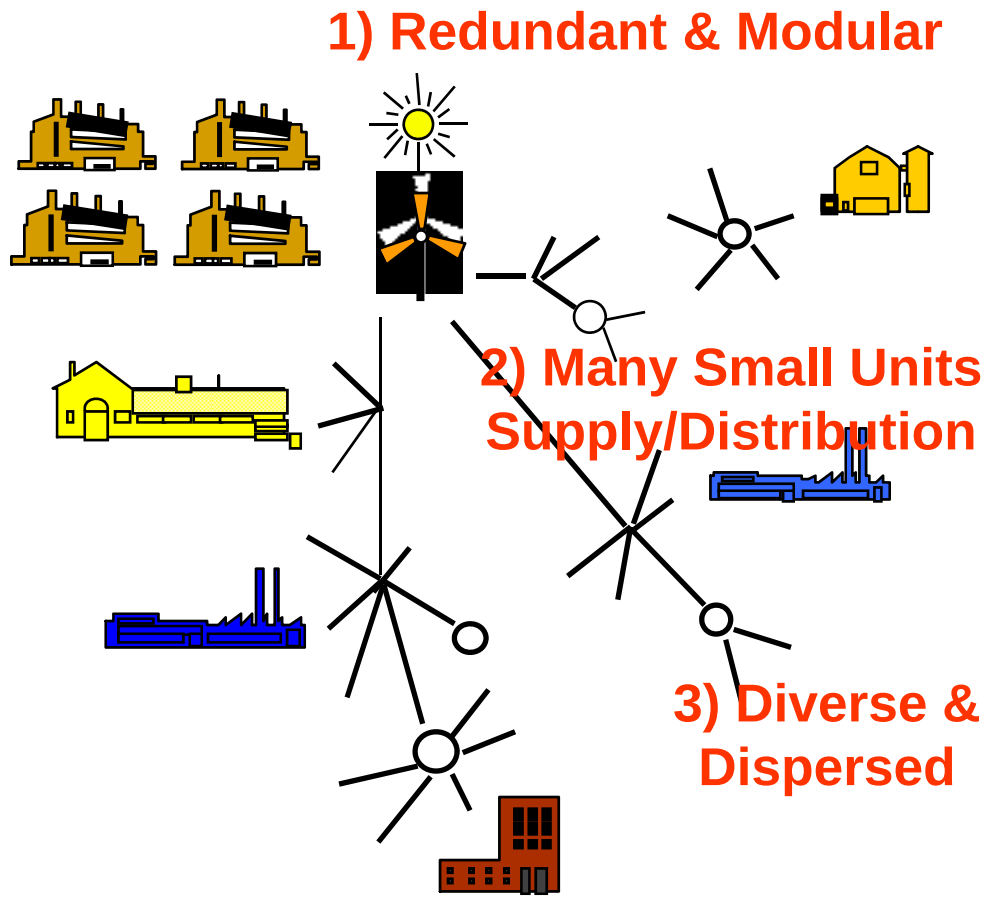
Characteristics of a Decentralized System

Operate in Isolated Modes

Located Close to End Users-

<u>User Controllability</u>

Storage Buffers Failure



Based upon Lovins, Amory B. and Lovins, L. Hunter, <u>Brittle Power, Energy Strategy for National Security</u>, 1982. P. 218

Distributed Resources

Distributed resources include conservation and load management with modular electric generation and/or storage located near the point of use either on the demand or supply side. DR includes fuel-diverse fossil and renewable energy generation and can either be grid-connected or operate independently. Distributed resources typically range from under a kilowatt up to 50 MW. In conjunction with traditional grid power, DR is capable of high reliability (99.9999%) and high power quality required by a digital society

Composite definition of US DOE(2), EPRI(2), CEC(1), AGA(1)

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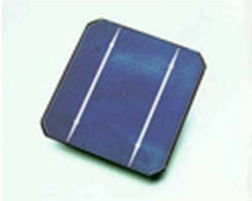
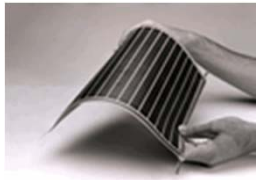
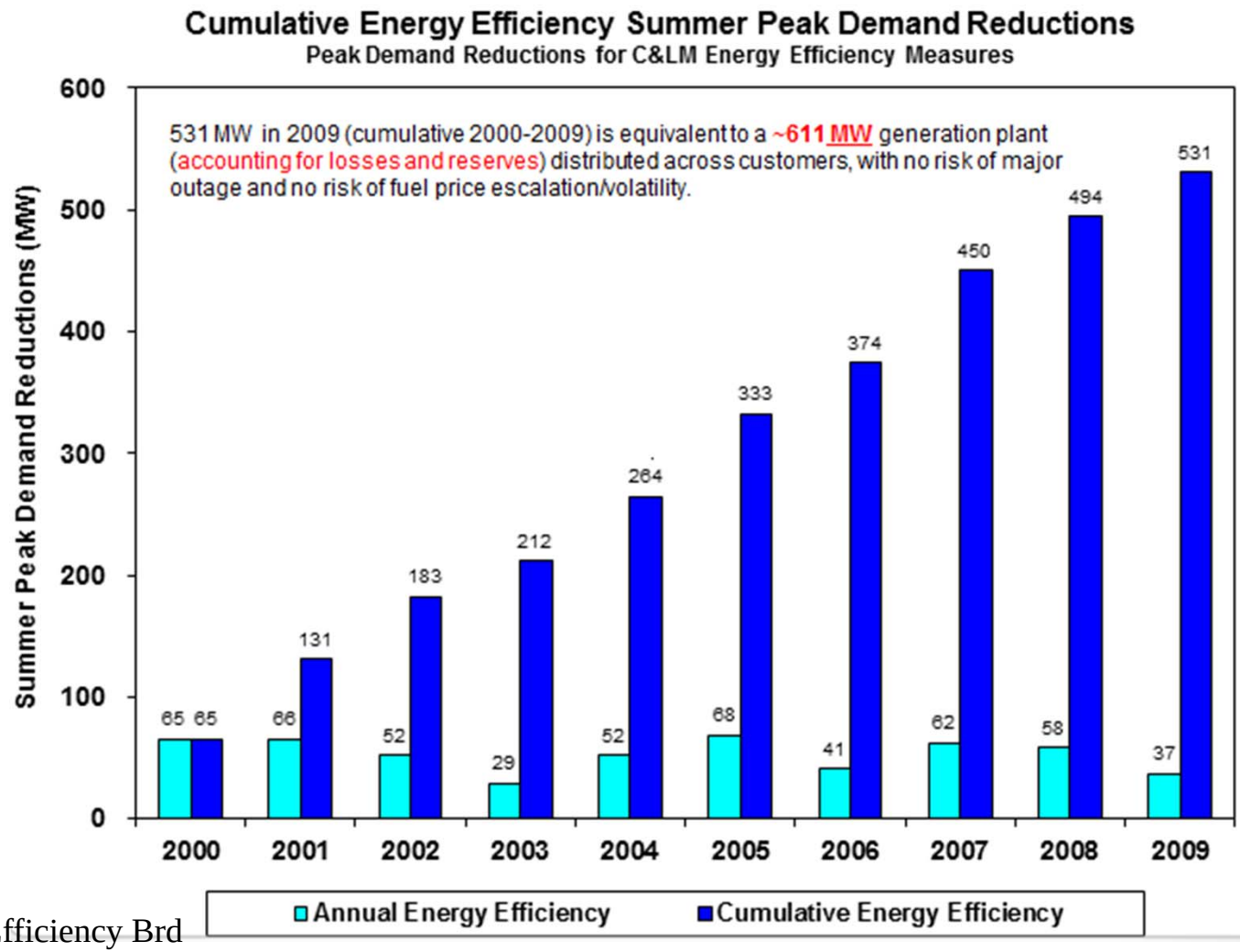




First Things First! Building a C&LM Powerplant PA 07-242 Secs. 51-52 Await Implementation

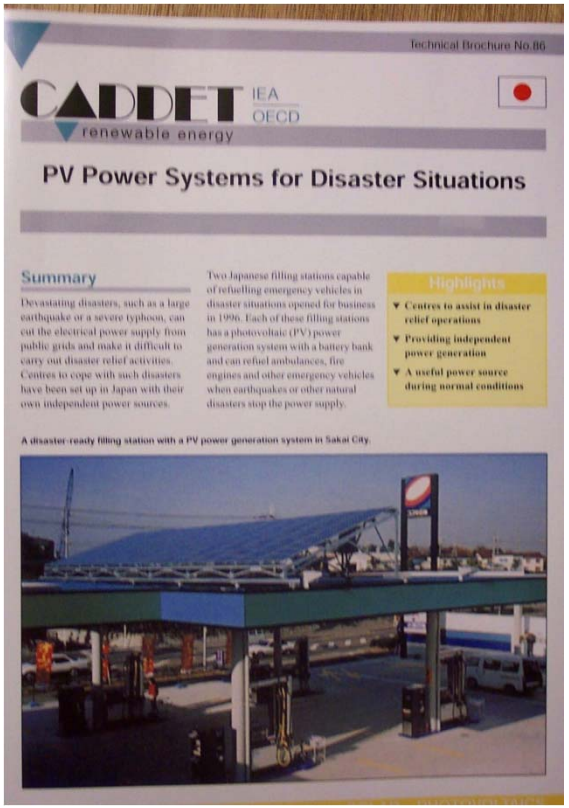


CT Energy Efficiency Brd

Then Go To High Value, "Killer Apps"

"The power failure created traffic jams on Connecticut highways. On the Merritt Parkway cars ran out of gas because power had shut service stations."

-Hartford Courant 8/15/03



Technical Brochure No.86

CADDET IEA OECD

renewable energy

PV Power Systems for Disaster Situations

Summary

Devastating disasters, such as a large earthquake or a severe typhoon, can cut the electrical power supply from public grids and make it difficult to carry out disaster relief activities. Centres to cope with such disasters have been set up in Japan with their own independent power sources.

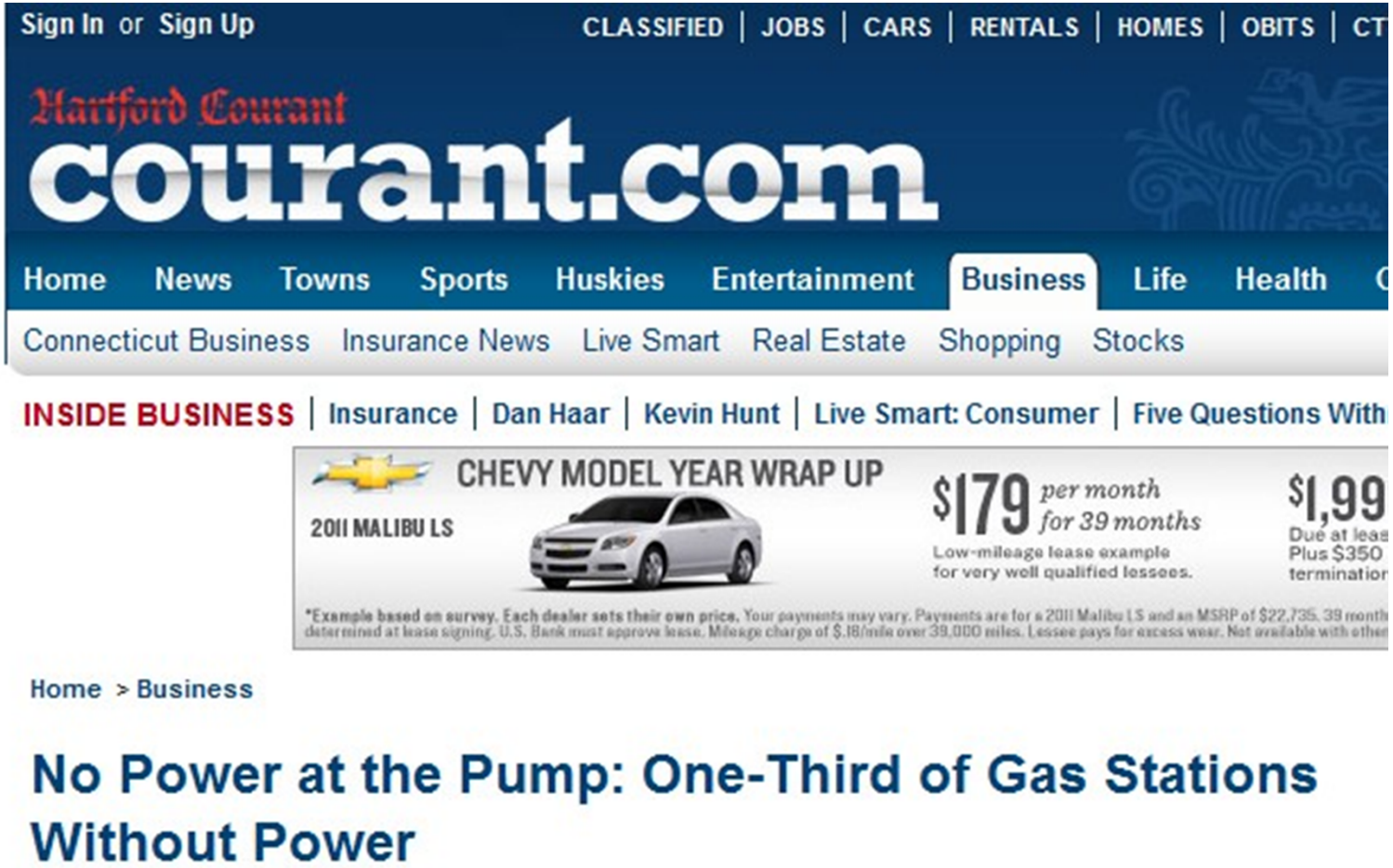
Two Japanese filling stations capable of refuelling emergency vehicles in disaster situations opened for business in 1996. Each of these filling stations has a photovoltaic (PV) power generation system with a battery bank and can refuel ambulances, fire engines and other emergency vehicles when earthquakes or other natural disasters stop the power supply.

Highlights

- Centres to assist in disaster relief operations
- Providing independent power generation
- A useful power source during normal conditions

A disaster-ready filling station with a PV power generation system in Sakai City.

That High Value, "Killer App" Did Not Happen - YET



High Value Applications are Everywhere

You Just Have to Think About the Circumstances

"Businesses shut down early, held hostage by electronic cash registers." Hartford Courant 8/15/03

Even Small Amounts of Electricity Available In a Timely Manner Can Be Life Savers

NEW BRITAIN REGION

Nursing home hit by power outage; staff help patients breathe

October 3, 2002

Associated Press

WATERBURY, Conn. – Staff members at a nursing home had to help 17 patients breathe for a half-hour Wednesday night when a backup generator failed to turn on during a power outage.

Nursing home workers and emergency medical technicians used bag devices to pump air into the lungs of 17 patients on the second floor who rely on electric-powered ventilators.

…and Nine Years Later

Johnson Memorial Medical Center's Power, Coming from two CL&P Power Feeds, Failed As Did Back-up

Hartford Courant

courant.com

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When Power Generator Fails, Hospital Takes Extreme Measure

Medical Community Unites To Move 43 Patients From Rooms, To Ambulances, To Other Hospitals, Health Centers

Comments 0 Recommend Tweet 0 Share 6 +1 0

By WILLIAM WEIR, bweir@courant.com
The Hartford Courant

Widespread failure of Cellphone Systems On August 14, 2003 Drove Home Lessons

Hurricane Irene Blows A Hole Through East Coast Communications

Sarah Lai Stirland | August 29, 2011, 4:16PM Recommend 41

41 Share 16 Tweet 0 Digg

The extent of the damage wreaked on the East Coast's communications infrastructure became more apparent on Monday as new reports trickled in to the Federal Communications Commission.

As of Monday afternoon, as the storm moved north, the commission reported that 44 percent of the cell tower sites in Vermont are out of service, more than a third are out in Connecticut, 31 percent are out in Rhode island, and a quarter are out of service in Virginia.

Meanwhile, the percentage of cell sites that are out of service in North Carolina declined slightly to 11 percent from 14 percent.

EPRI's Framework for the Future

A portfolio of innovative technologies…. can comprehensively resolve the vulnerability of today's power supply …These "smart technologies" will also open the door to fully integrating distributed resources and central station power into a single network, in a manner than can reduce system vulnerability rather than add to it-as is typically the case today…

Electricity Sector Framework For The Future, Volume I, Achieving A 21st Century Transformation.
Electric Power Research Institute. August 6, 2003. p. 31.

Enter the Smart Grid With Claims

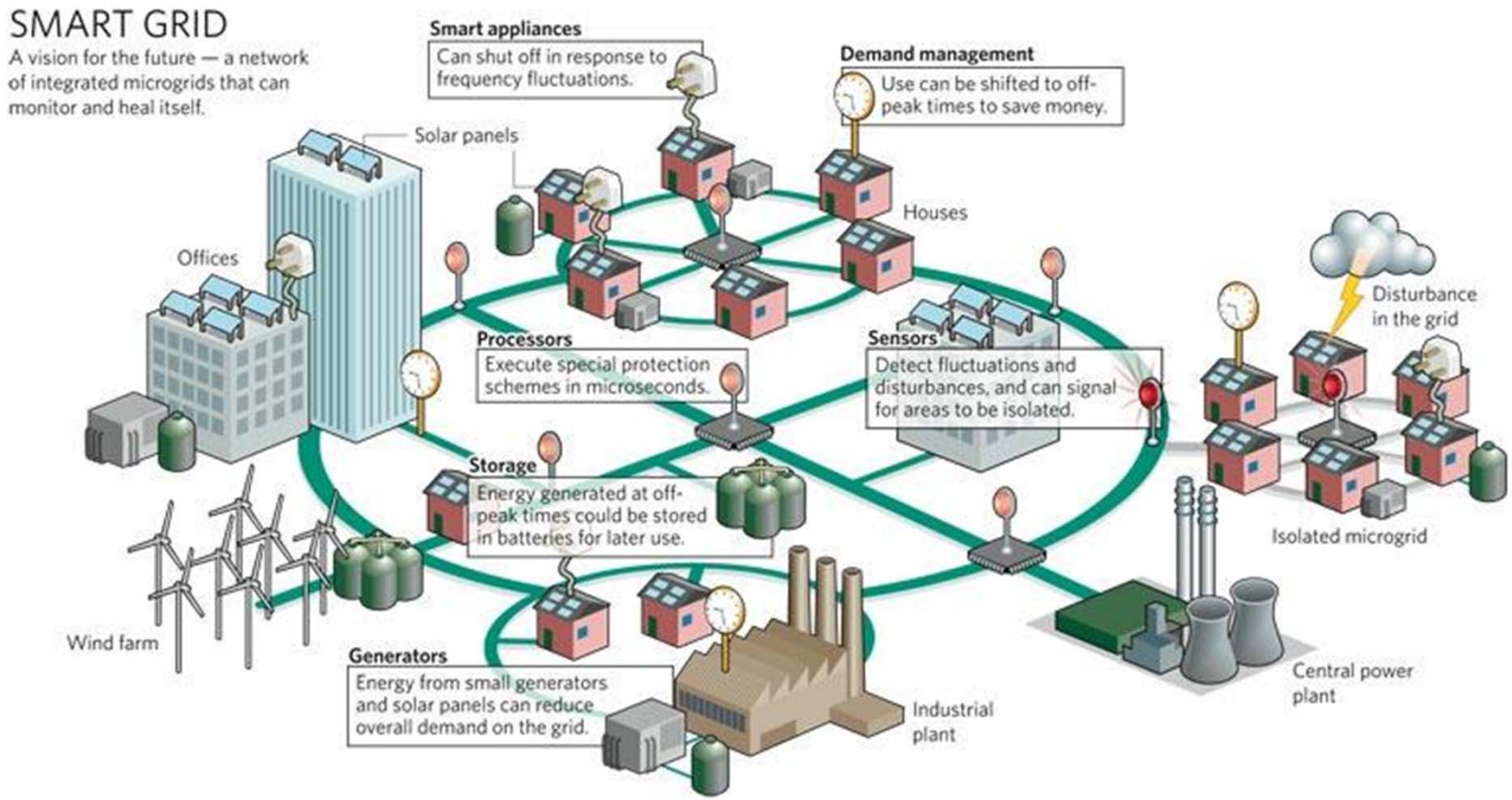
- Improved reliability, security and efficiency through digital control
- Optimization of grid operation & Self Healing
- Easier interconnection of distributed resources and smart appliances
- Control of demand response down to the consumer appliance level

ISO-NE. *Overview of the Smart Grid Policies, Initiatives, and Needs*. February 17, 2009. pp. 2-3. Also L. Kiesling *A Smart Grid is a Transactive Grid*, Part 2 of 5 parts, March 3, 2009.

Smart Grid (con't.)

- Provision for storage technology including plug-in hybrid vehicles
- Real time information on electric pricing for transactive procurement
- Requires standards/security for communications and interoperability
- Requires overcoming barriers to adoption of Smart Grid technologies

ISO-NE. *Overview of the Smart Grid Policies, Initiatives, and Needs*. February 17, 2009. pp. 2-3. Also L. Kiesling *A Smart Grid is a Transactive Grid*, Part 2 of 5 parts, March 3, 2009.



Energy: Upgrading the Grid, Nature, vol. 454, pp. 570–573, 2008.

A Shoe Company Can Do It!
Enter the Bionic “Smart” Shoe

"Each second, a sensor in the heel can take up to 20,000 readings... directing a tiny electric motor to change the shoe." Michael Marriott, New York Times. "The Bionic Running Shoe," May 6, 2004.

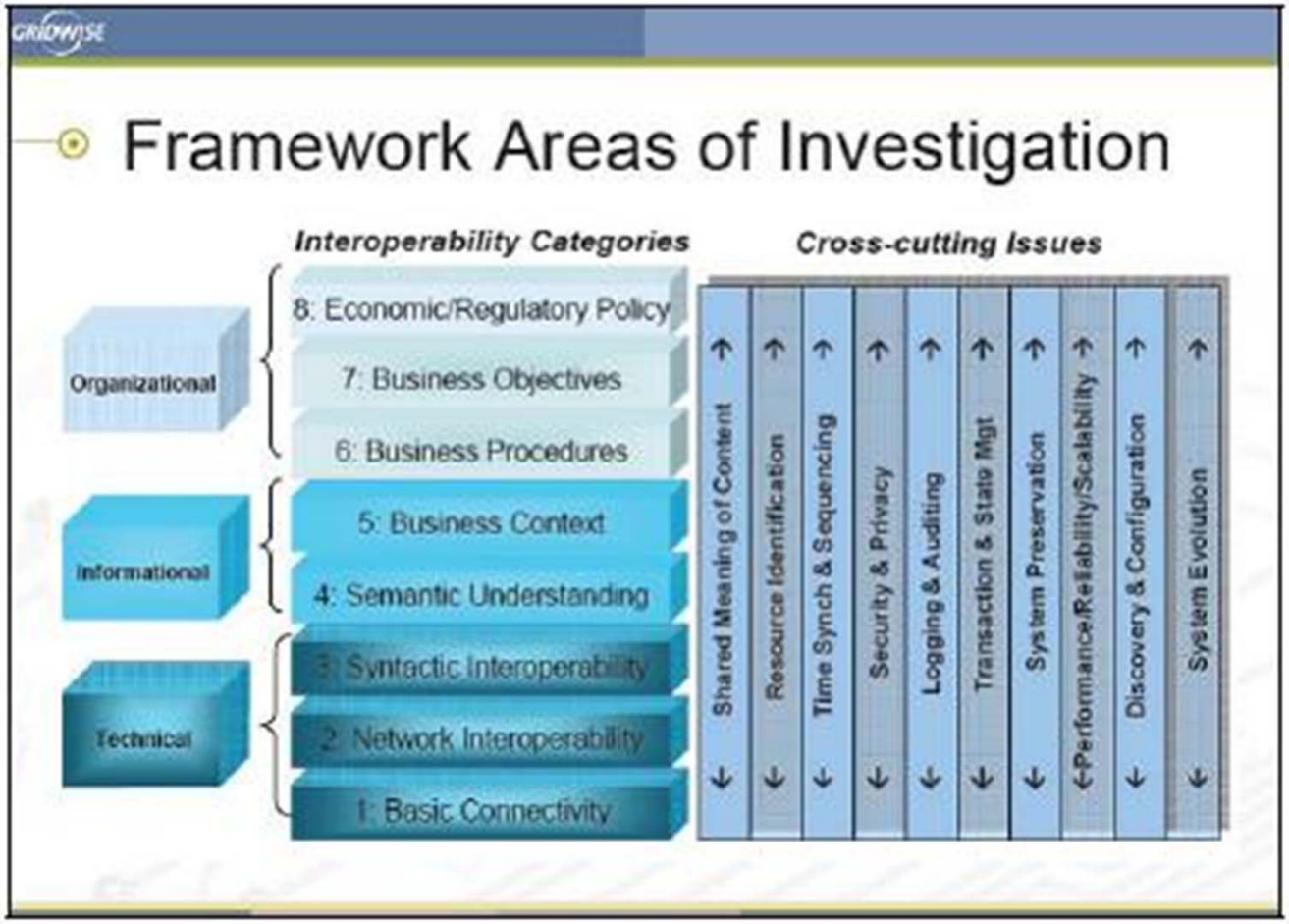


Figure 2: Smart Grid interoperability framework and cross-cutting issues.
Source: The Gridwise™ Architecture Council, 2008 (GWAC-1)

ISO-NE. *Overview of the Smart Grid Policies, Initiatives, and Needs*. February 17, 2009.

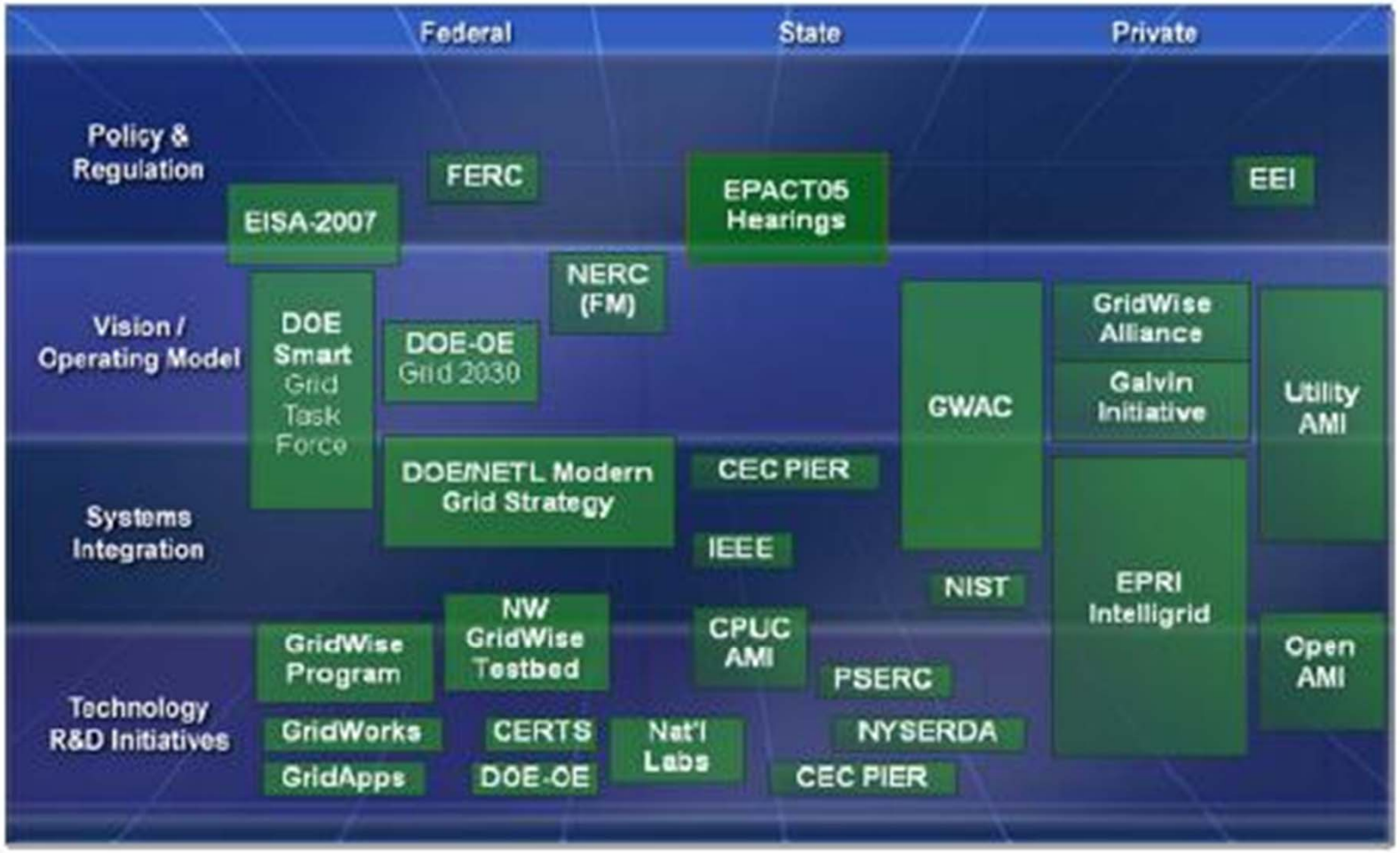


Figure 1: Selected federal, state, and private Smart Grid initiatives.

Source: E. Lightner, 2008 (Lightner-1)

ISO-NE. *Overview of the Smart Grid Policies, Initiatives, and Needs*. February 17, 2009.

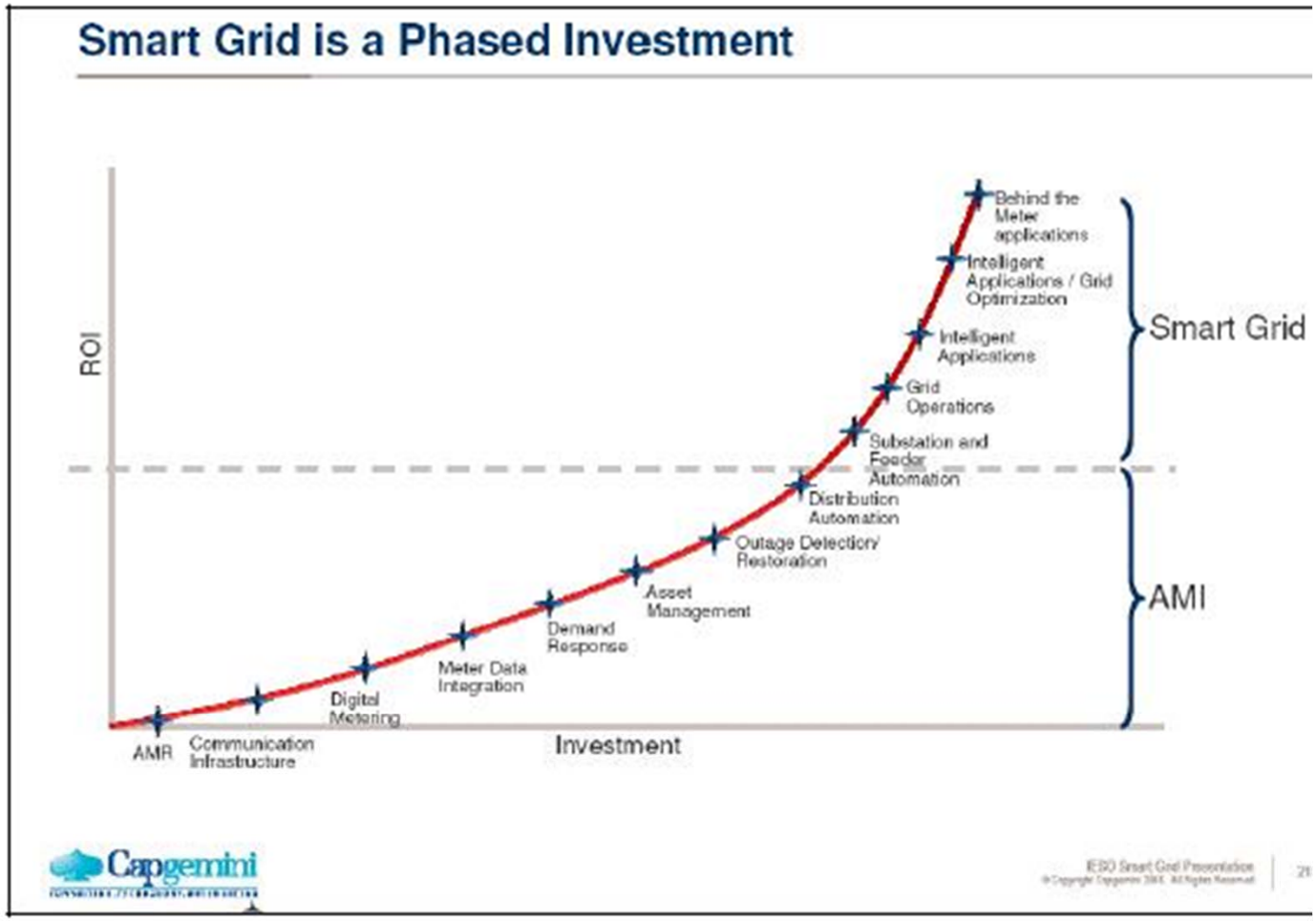


Figure 6: The phased return on investments from advanced metering infrastructure to Smart Grid.

Source: Independent Electricity System Operator (IESO), 2008

ISO-NE. *Overview of the Smart Grid Policies, Initiatives, and Needs*. February 17, 2009.

EPRI Studies Pinpoints the Problem

Lack of technical innovation strongly reflects the state of uncertainty in the electricity sector. Technology decisions are largely driven by the management of existing assets... **Capital expenditures as a percent of revenue are at an all-time low... There is little incentive for introducing new technology…**

Who Sets Utility Rates of Return/Incentives Anyhow?

Electricity Sector Framework For The Future, Volume I, Achieving A 21st Century Transformation.
Electric Power Research Institute. August 6, 2003. p. 31

Solutions?--Show ~~Me~~ Them the Money!

"Improved security from distributed generation should be credited when planning the future of the grid….Recovery of the invested funds through rate mechanisms or in some part through homeland security funding must be examined."

Security As A Positive Externality?

Making the Nation Safer The Role of Science and Technology in Countering Terrorism, National Academy Press, p.192.

The Electric Power Research Institute (EPRI) Concurs

Protecting the nation's power infrastructure has a strong public-good dimension, and a robust federal "homeland security" incentive will be needed from the outset. Investments made for such essential infrastructure security must be immediately and fully recoverable.

Electricity Sector Framework for The Future, Volume I, Achieving A 21st Century Transformation. Electric Power Research Institute. August 6, 2003. p. 7.

Short & Long-Term Recommendations

- **Maximize Energy Efficiency per PA 07-242 Secs. 51-52**
- **Plan Energy Resiliency into High Value Applications**
- **Provide Rate of Return for Utility Resiliency Actions**
  Use Decoupling, Other Mechanisms
- **Incentives for DG, CHP to Utility & Private Sector**
- **Implement a Plan Incrementally But With Annual Targets**
- **Minimize Transmission Projects and Investments**
- **Apply for DHS and Other Federal Funding**
- **Make Insurers Partners to Reduce Their Losses and Contribute Their Expertise –and Funding**

Dilbert by Scott Adams

Questions?

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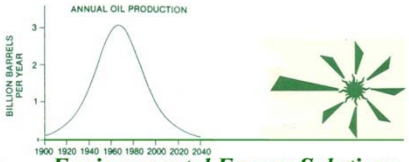
TerraChoice Environmental Marketing.



Environmental Energy Solutions

There Were Some Early Warnings But, of Course, These Were Ignored

Feb1978

Vulnerability of Electric System

While letter writer Roslyn A. Fader on Feb. 21 extolled the virtues of our nuclear systems over the short-supplied coal facilities in Indiana, she totally ignored the problem at hand, which is that centrally generated electricity is a vulnerable genie. In order to be used, it must travel on an ugly, complex and inefficient labyrinth of wires and substations. Indeed, as reported in The Courant, during the recent extreme weather, Boston lost power due to a mere piece of tar paper blown into the distribution wires of a main substation. Even from a security view (national or otherwise) such a fragile system is suicide.

Couple with this the Feb. 21 front page article concerning the Electricity Consumers Resource Council, whose aim it is to prevent "lifeline rates" while perpetuating its own economic advantages. It is for these large users that excess capacity must be built and maintained, for which everyone pays.

What infuriates me most is the order in which those aims are listed — lifeline denial coming first!

This dictatorial central system must be economically and technologically dashed into obsolescence.

Joel N. Gordes

Winsted

Even Pearl Harbor Was No "Surprise"Except for Those Caught in Cultural Lags

("We Always Prepare for the Last War")

General Billy Mitchell
U.S. Assistant Chief of Air Services
October 24, 1924

"…I am convinced that the growing airpower of Japan will be the decisive element in the mastery of the Pacific…Air operations for the destruction of Pearl Harbor will be undertaken…The attack to be made on Ford Island at 7:30 a.m… The Philippines would be attacked in a similar manner…The initial successes would probably be with the Japanese."

April 1926

He proved to be a visionary when in 1926…fifteen years before WWII, he said:

"A surprise aerial attack on Pearl Harbor will take place while Japanese negotiators talk peace with the U.S. officials, moreover the attack will come on a Sunday Morning."

- Other threats and considerations including “unintended consequences” Whas’ that mean?

More than 4 million lose power in major blackout

Arizona utility worker triggers a chain reaction that reaches from Mexico to Orange County, bringing routine life to a halt.

"The outage appears to be related to a procedure an APS employee was carrying out in the North Gila substation," ... "Operating and protection protocols typically would have isolated the resulting outage to the Yuma area. The reason that did not occur in this case will be the focal point of the investigation into the event, which already is underway."

Other threats and considerations including "unintended consequences" – Whas' that mean?

Power back on for 1.4 million San Diego customers

By JULIE WATSON, Associated Press
Posted: 09/09/2011 06:14:34 AM PDT
Updated: 09/09/2011 06:17:57 AM PDT

A man tries to syphon gas from a car during a power outage Thursday, Sept. 8, 2011, in San Diego. A power outage is affecting millions of people across southern California, Arizona and Mexico. San Diego Gas & Electric Co. Darcel Hulces said that crews Thursday believe the outage was caused by a system breakdown and assured people it was not the result of a terror attack. (AP Photo/Gregory Bull)

SAN DIEGO -- Electricity was restored in San Diego early Friday after utility crews worked around-the-clock to make emergency repairs following an outage accidentally triggered by a utility worker that darkened a swath of California, Arizona and Mexico and paralyzed the nation's eighth-largest city.

"This was not a deliberate act. The employee was just switching out a piece of equipment that was problematic,"…It's possible that extreme heat in the region also may have caused some problems with the transmission lines…

Creating Micro-Grids

Pinched by soaring energy costs and the need for economic development, a growing number of Connecticut cities and towns are exploring setting up their own energy micro-grids. It's an intriguing idea.

Legislation authorizing the so-called "energy improvement districts" was adopted by the General Assembly last year. It gives municipalities the authority (and a lot of flexibility) to establish the districts and provide assistance, including issuing and guaranteeing a district's bonds to build energy facilities. Property owned by the district would be tax-exempt, although a district can make payments in lieu of taxes.

TAPPING LOCAL SOLUTIONS

Municipalities can shape their own energy destinies

The goal of the legislation is to enable neighboring businesses, industries or institutions like schools and municipal office buildings to share in the benefits of cheaper, dependable, locally generated energy and energy conservation. The concept is similar to the urban business improvement districts created in the 1980s in which participating businesses paid a small tax to fund their own security and clean-up crews.

The concept is catching on. In just the last few months, districts were established in Ansonia and Stamford. Berlin, Bridgeport, New Haven, Oxford, Wethersfield, Manchester and Watertown are considering them, too.

Newly built power plants are more efficient. They also present opportunities for energy conservation. For example, a local power plant can use surplus heat to meet the heating and cooling needs of neighboring customers of the energy improvement district. These districts can also benefit from state incentives that encourage newer and cleaner energy technologies such as fuel cells, solar and wind power. In Stamford, officials are exploring using geothermal energy to address the district's needs.

Finally, by generating their own power, these districts can promise customers reliable energy at predictable prices. If enough municipalities create districts, they can reduce demand on the larger transmission system, which is struggling to meet peak demand.

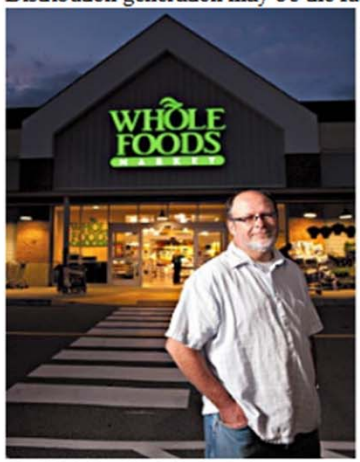
It's too early to know how well these districts can deliver. But the approach, which encourages innovation and small-scale solutions to local energy needs, is very promising.

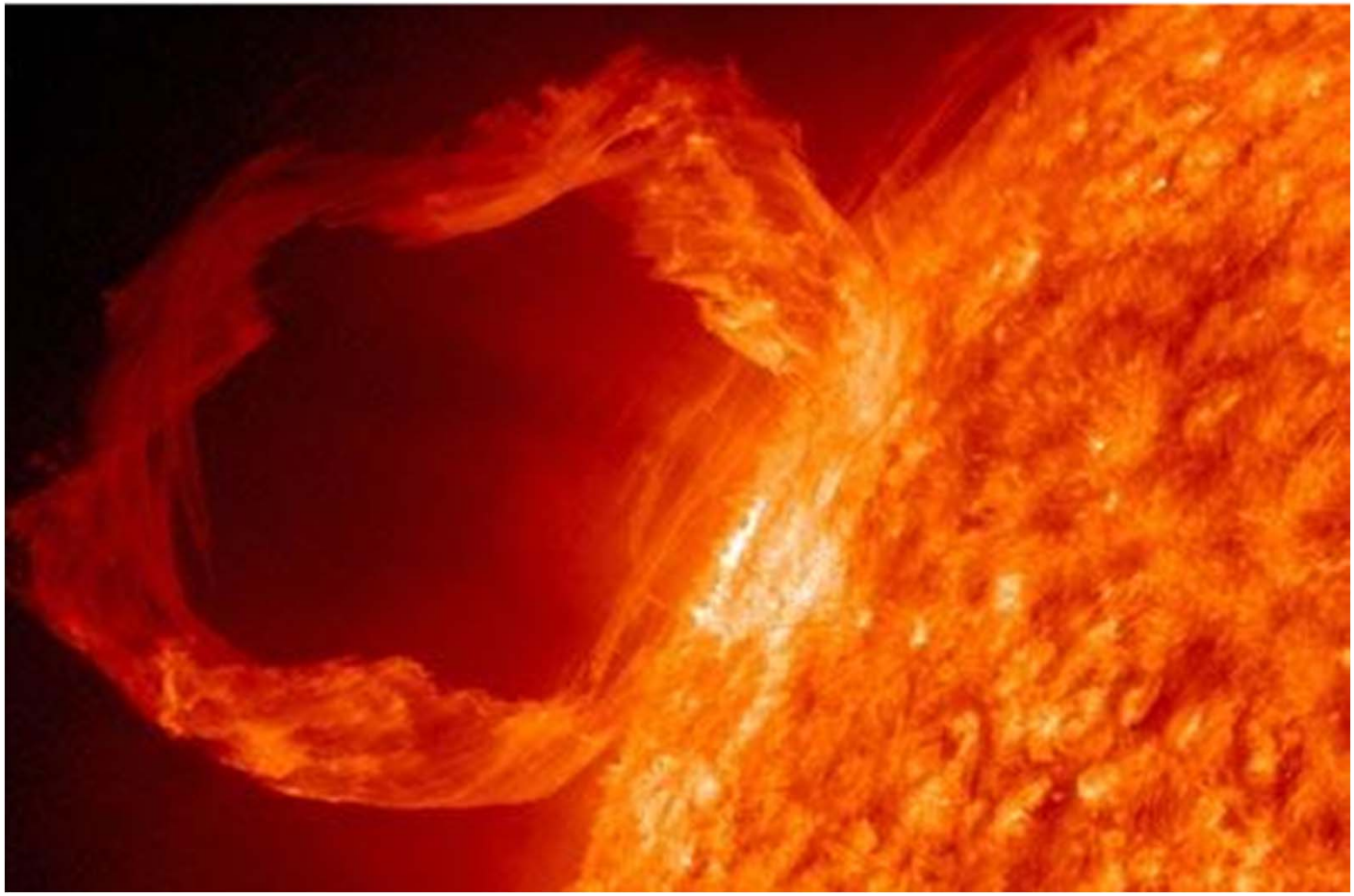
2/19/08

Distributed generation kept lights on after Irene

By Brad Kane
bkane@HartfordBusiness.com
Sep 5, 2011

Distribution generation may be the future of the power industry, but following Irene's blackouts, several Connecticut businesses were glad they signed up for the future early.



STEVE LASCHEVER

The Whole Food Market in Glastonbury powered up ahead of the grid, in part, because of an onsite fuel cell. The fuel cell also kept refrigerators working during the blackout, minimizing the food loss, store team leader Tom Neal said.