Solar Energy Technologies - Contributing to a Robust Energy Infrastructure

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Our Energy Infrastructure Faces a Broad Spectrum of Threats

- **Physical** – Terrorism, natural disasters, accidents, global warming, and aging infrastructure
- **Cyber** – Malicious intrusion and inadvertent error
- **System complexity** – Cascading effects, critical nodes, and interdependencies
Our Energy Infrastructure is Difficult to Protect

- 158,000 miles of main electric transmission lines
- 5,000 power plants (totaling 800,000 megawatts)
- 2,000,000 miles of oil pipelines
- 1,300,000 miles of gas pipelines
- 2,000 petroleum terminals
- 1,000,000 gas and oil wells
- 150 oil refineries
- 300 tankers (ships)
- Plus much, much more!
Our Imported Fuels

- Oil: 11 million bbl/day (55% of our daily consumption)
- Natural gas: (15%)
- Electricity (1%)
U.S. Natural Gas Pipeline Systems and Liquefied Natural Gas Import Facilities 2001

Legend
- Interstate Pipelines
- Intrastate and Other Pipelines
- LNG Import Facilities (Active)
- LNG Import Facilities (Reactivation underway)

Source: Office of Oil and Gas, Energy Information Administration (EIA), United States Department of Energy.

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Natural Gas Pipeline Capacity Serving the U.S. Marketplace

Source: Office of Oil and Gas, Energy Information Administration (EIA), United States Department of Energy.
Electric Power Plants in the U.S.

Source: Office of Oil and Gas, Energy Information Administration (EIA), United States Department of Energy.
U.S. Electric Power Transmission Grid

Source: Office of Oil and Gas, Energy Information Administration (EIA), United States Department of Energy.
Blackout! It Can Happen To You.
July 2, 1996

Before

After

Courtesy Bill Becker DOE Denver Regional Office
Business Losses from Power Outages

Power outages and power quality disturbances cost the U.S. economy more than $119 billion annually (Electric Power Research Institute, 2001)
What is the Value of Electricity if you don't have any?
The Role of Technology in Energy Assurance

• “...we will rely upon the genius and creativity of the American people. Our scientific community is serving on the front lines of this war by developing new technologies that will make America safer.” (President Bush, 2002)

• “... America’s vast science and technology base provides us with a key advantage.” (President Bush, 2002)
How is DOE Involved?

• The President assigned the responsibility for insuring the robustness of the U.S. energy infrastructure to the Secretary of Energy (PDD-63, 1998)

• “Energy security is DOE’s #1 priority.” (Deputy Secretary Frank Blake’s charge to the Interlabatory Task Force, December 2001)
Where do the Labs Fit In?

The Secretary of Energy considers the DOE National Laboratory system as key players in developing and transferring innovative technologies to the private sector, as well as state and local government.
The Mission of the Interlaboratory Task Force

“...identifying DOE technologies and capabilities that can protect our nation’s critical energy infrastructure and facilitating their use by the private sector and other federal agencies.”

(memo creating the Interlaboratory Task Force from Deputy Secretary Frank Blake, November 2001)
The Key to a Robust Energy Infrastructure

- Reduced domestic energy consumption
- Reduced dependence on imported fuels
- Distributed generation
- “Smart systems”
- Resiliency
- Diversification
The Role of Energy Efficiency

*Business Week* estimates that in 10 years, U.S. energy efficiency could be raised by 50% and reduce daily oil consumption by more than 27% (3 million bbl) per day – at less than the cost of a major oil price rise.
Mid- to Long-Term Opportunities for Solar Technologies in Energy Assurance

- Reduce dependence on imported oil
- Reduce U.S. energy consumption and relieve stress on infrastructure (self-sustaining buildings, SDHW and heating, utility and grid-connected power, as well as grid-independent power)
Typical U.S. Building Sector Energy Use

- Buildings use 65% of electrical energy consumed annually
- Building energy consumption in 2000 was 36.4 quads, or more than 1/3 of total U.S. energy use
High-Performance Buildings

A high-performance building using well-proven design features consumes 50% or more less energy than a conventional building.
Energy-Efficient Grid-Connected PV Home
(4 kW\textsubscript{pk}, Lakeland, FL)

Totals for June 1998

- Utility: 1839 kWh
- Solar: 502 kWh
- A/C only: 335 kWh
“Zero Energy” Buildings

Just think what buildings that produce all or more of their energy needs could do to reduce demand!
Near-Term Opportunities for Solar Technologies in Energy Assurance

- **Prevention** – Monitoring and detection
- **Mitigation** – Disaster-resistant, self-sustaining buildings; uninterruptible power (UPS), vandalism reduction, injury reduction
- **Response** – Emergency power
- **Recovery** – Backup power (UPS)
Green Buildings are Disaster-Resistant
Oil and Gas Field SCADA
Pipeline Power

Courtesy: Kyocera Solar
Refinery Protection/SCADA
Pipeline Control and Monitoring

Coutesy: Alternative Power Systems
Communications Power
Emergency Power for Medical Clinics

Courtesy: Florida Solar Energy Center
Mobile UPS

Courtesy: Live Oak Solar
Emergency Operations

Courtesy: Live Oak Solar
PV Systems are Disaster-Resistant

Before Hurricane Andrew, Picture facing N.E.  

After Hurricane Andrew, Picture facing N.W.

Before  

After  

Courtesy: Solar Outdoor Lighting
Contact Information

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