U.S. Department of Energy
Energy Efficiency and Renewable Energy

Solar Energy Technologies - Contributing to a Robust Energy Infrastructure

John P. Thornton, P.E.

Solar Program Review
March 24, 2003

033102e01

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

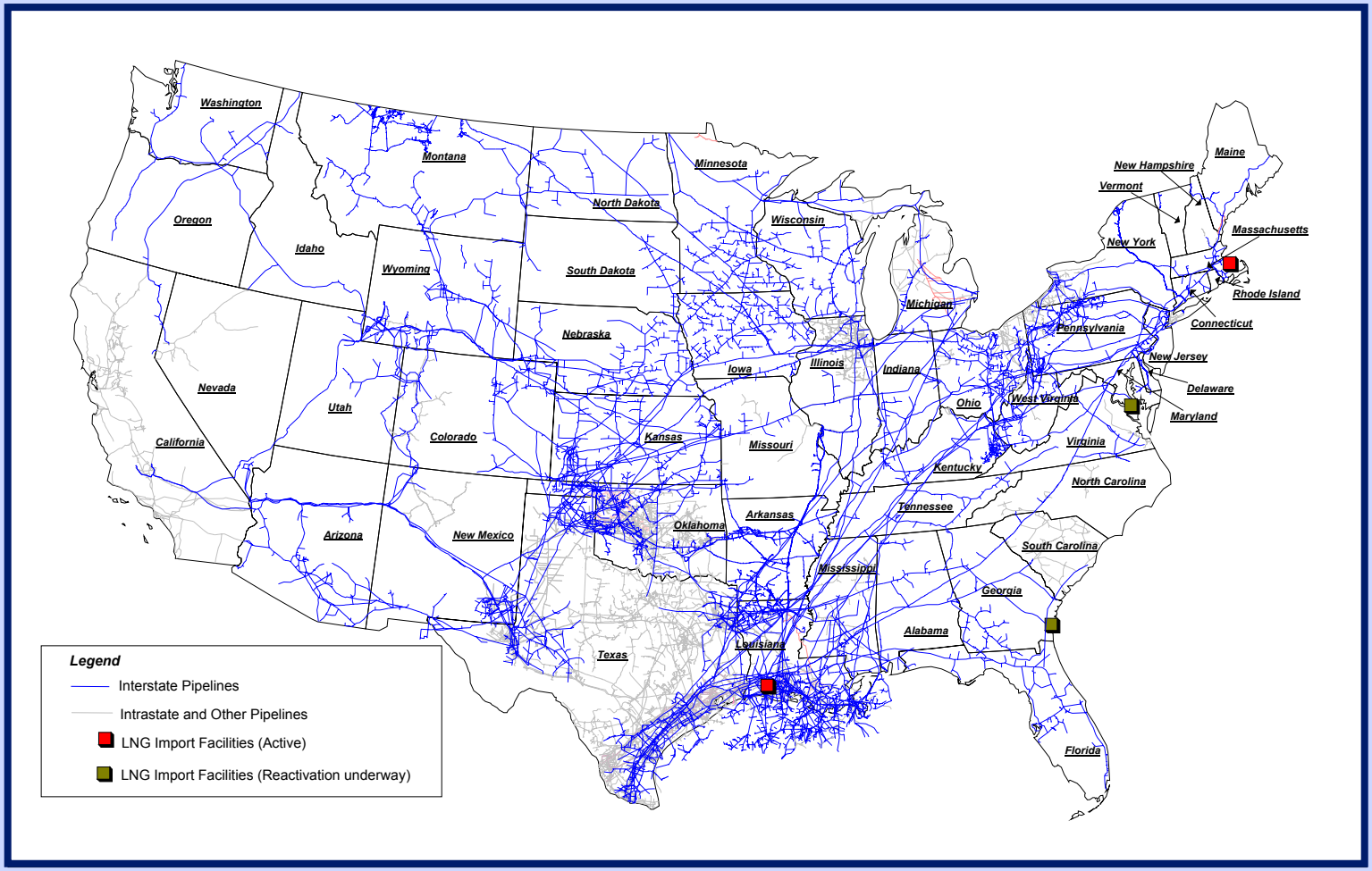
Our Energy Infrastructure is Difficult to Protect

- 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

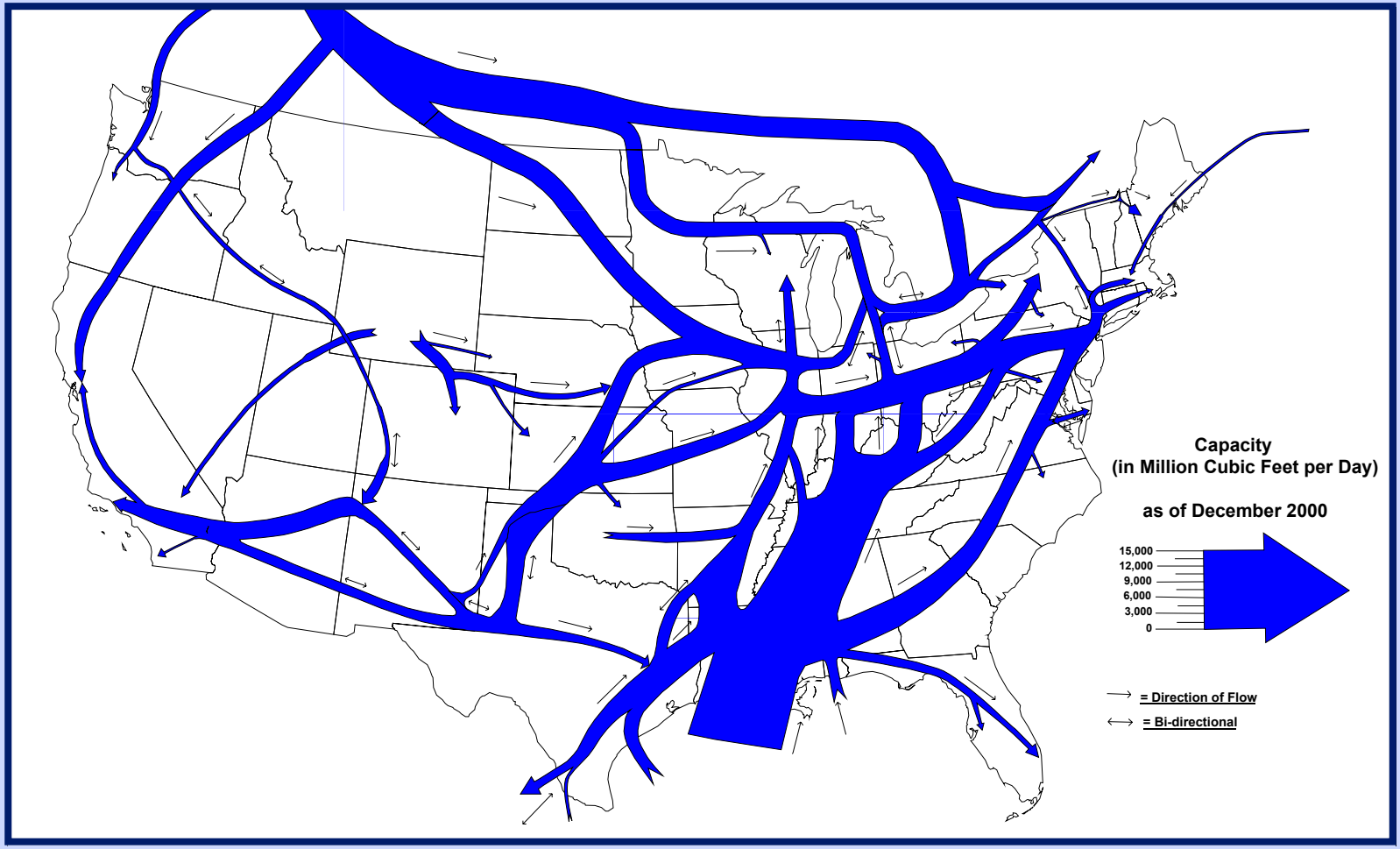
- Oil: 11 million bbl/day (55% of our daily consumption)
- Natural gas: (15%)
- Electricity (1%)

U.S. Natural Gas Pipeline Systems and Liquefied Natural Gas Import Facilities 2001



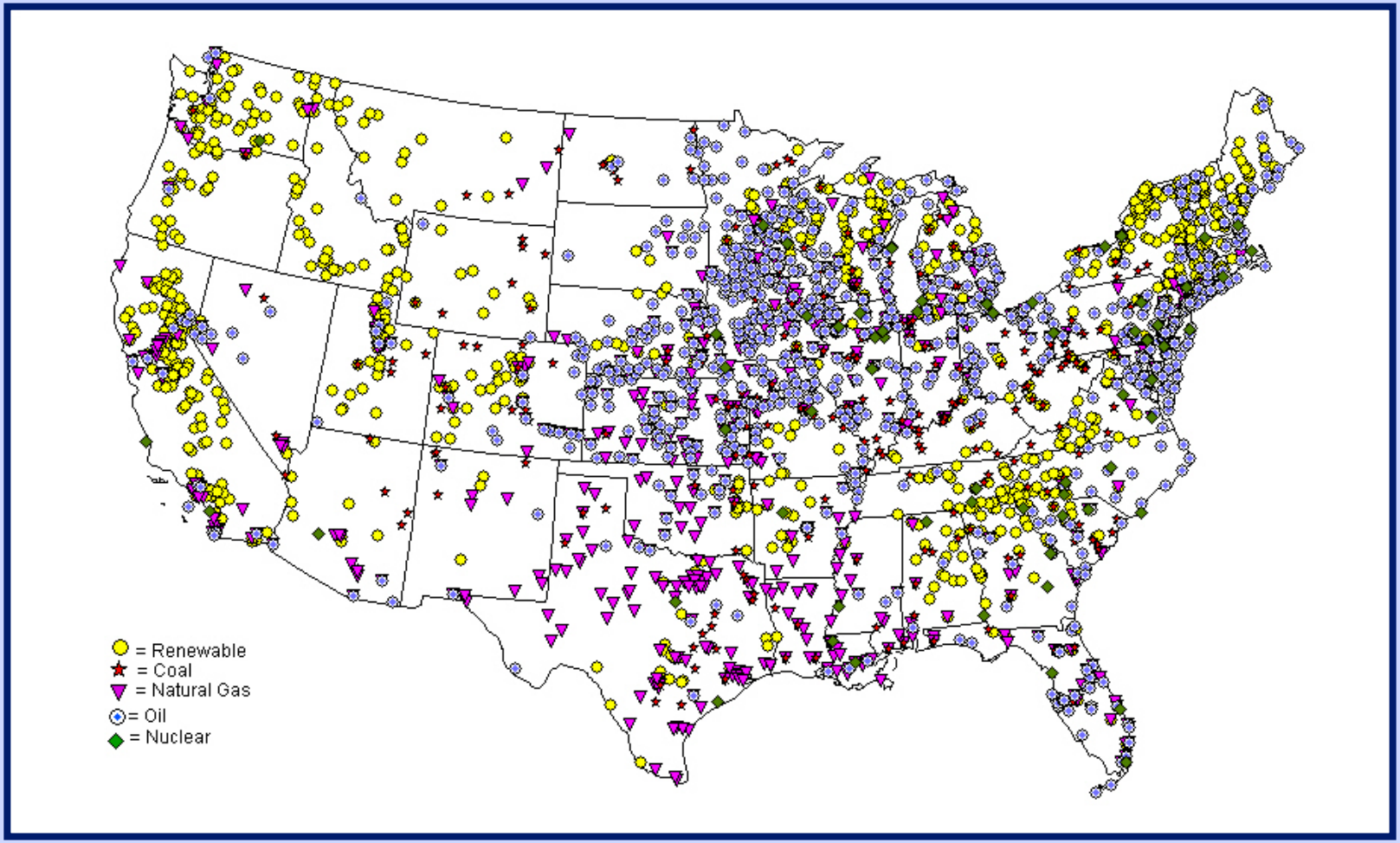
Source: Office of Oil and Gas, Energy Information Administration (EIA), United States Department of Energy.

Natural Gas Pipeline Capacity Serving the U.S. Marketplace



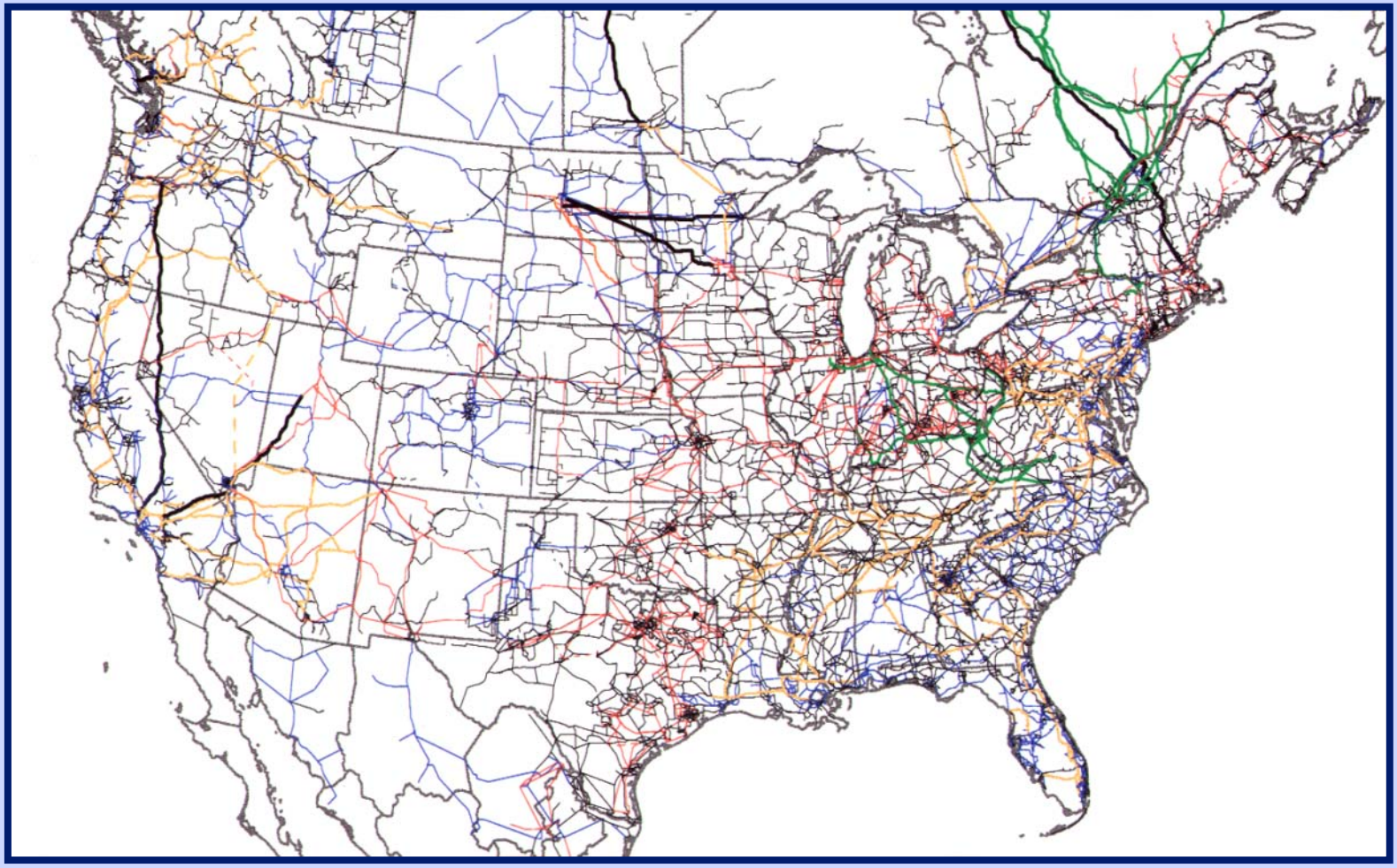
Source: Office of Oil and Gas, Energy Information Administration (EIA), United States Department of Energy.

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

Coutesy 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 Interlaboratory 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 transfering 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)

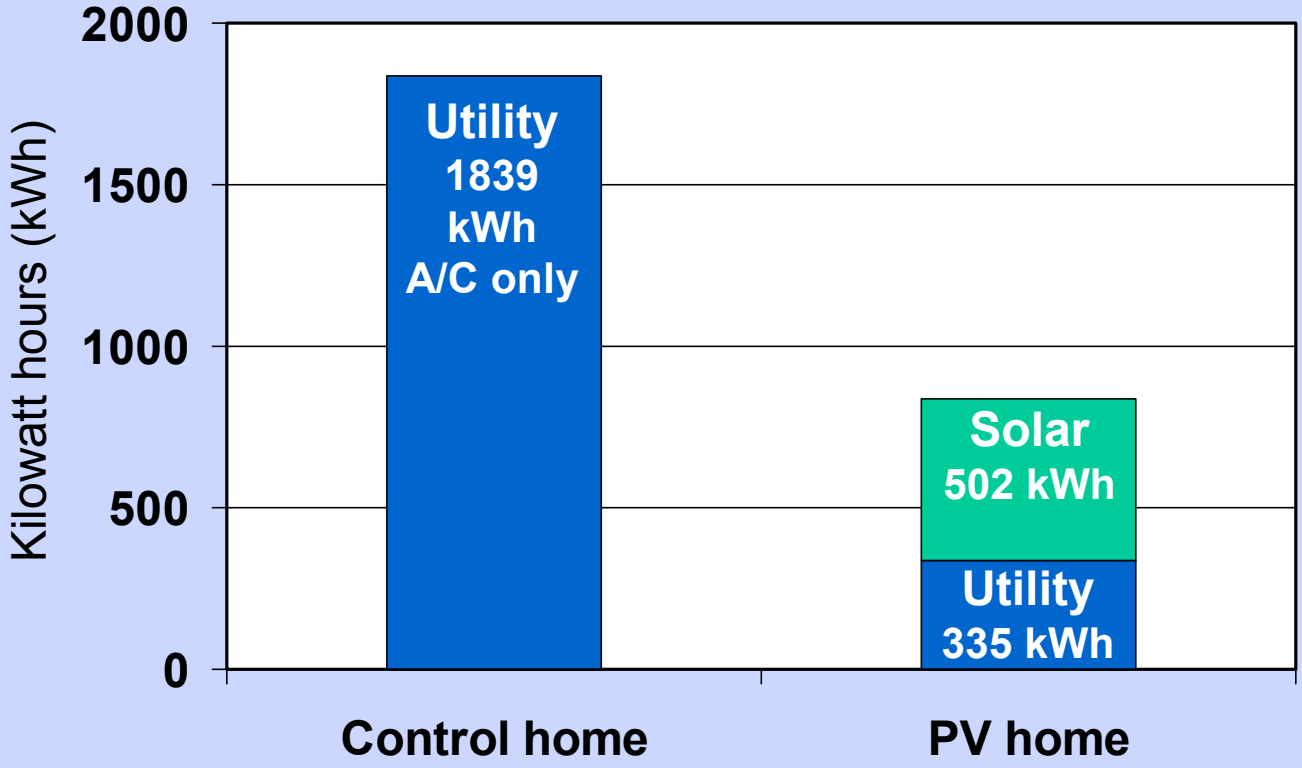
Typical U.S. Building Sector Energy Use

- 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_{pk} , Lakeland, FL)



Totals for June 1998

"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

033102f07

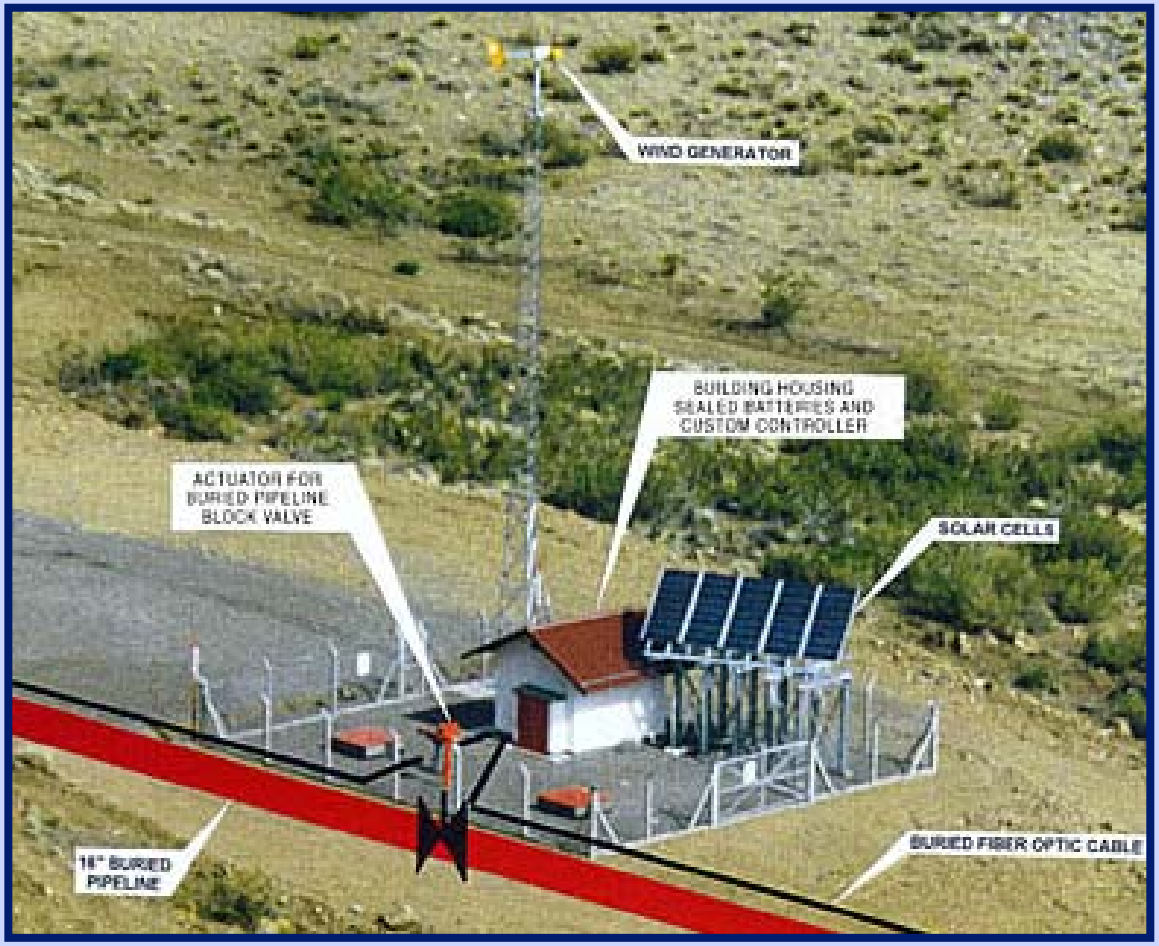
Pipeline Power

Courtesy: Kyocera Solar

Refinery Protection/SCADA

Courtesy: Alternative Power Systems

Pipeline Control and Monitoring



Coutesy: Alternative Power Systems

Communications Power

033102f06

Emergency Power for Medical Clinics

Coutesy: 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.

Before

After Hurricane Andrew, Picture facing N.W.

After

Courtesy: Solar Outdoor Lighting

Contact Information

For further information, contact:

John Thornton
National Renewable Energy Laboratory
303-384-6469
John_Thornton@nrel.gov