Distributed Energy Resources

Interconnection: Issues and Solutions

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to

Snohomish Public Utility District
Everett, Washington
September 18, 2002

A dig through the available data reveals that DG's potential value for improving reliability and efficiency within PJM remains substantially untapped. DG will expand, but the pace of its expansion remains unsure. Rules about standby charges, interconnection of DG, and other matters will affect the pace of its expansion, as will the ability of DG manufacturers to lower the cost of their product.

Just as important to the future of DG is the performance of the grid.

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Outline of presentation

The Interconnection context

- History, Technology, Definitions

The Interconnection challenge

- The nature of the problem, Identifying the barriers

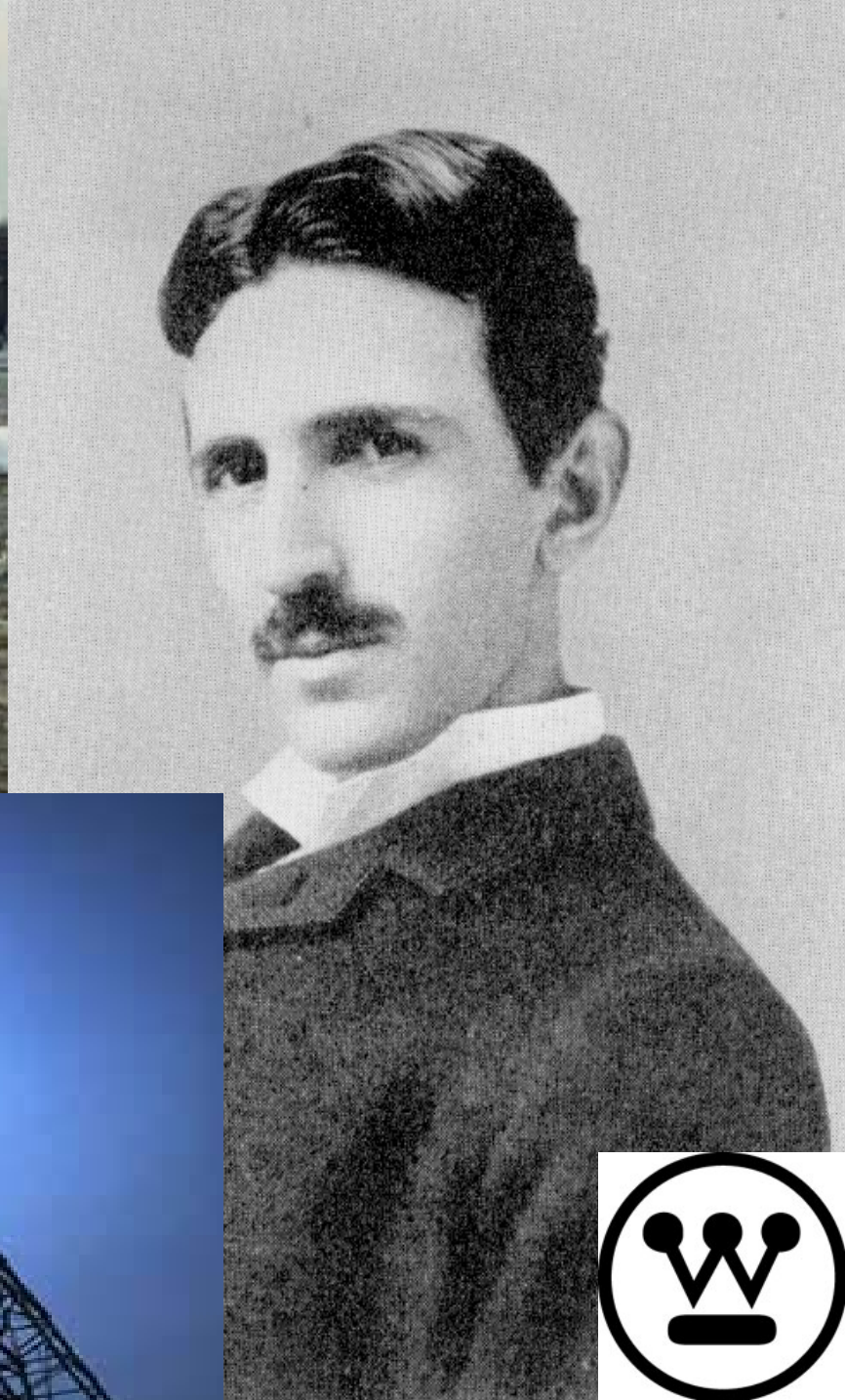
Addressing the challenge

- Industry standards, Federal actions, State actions

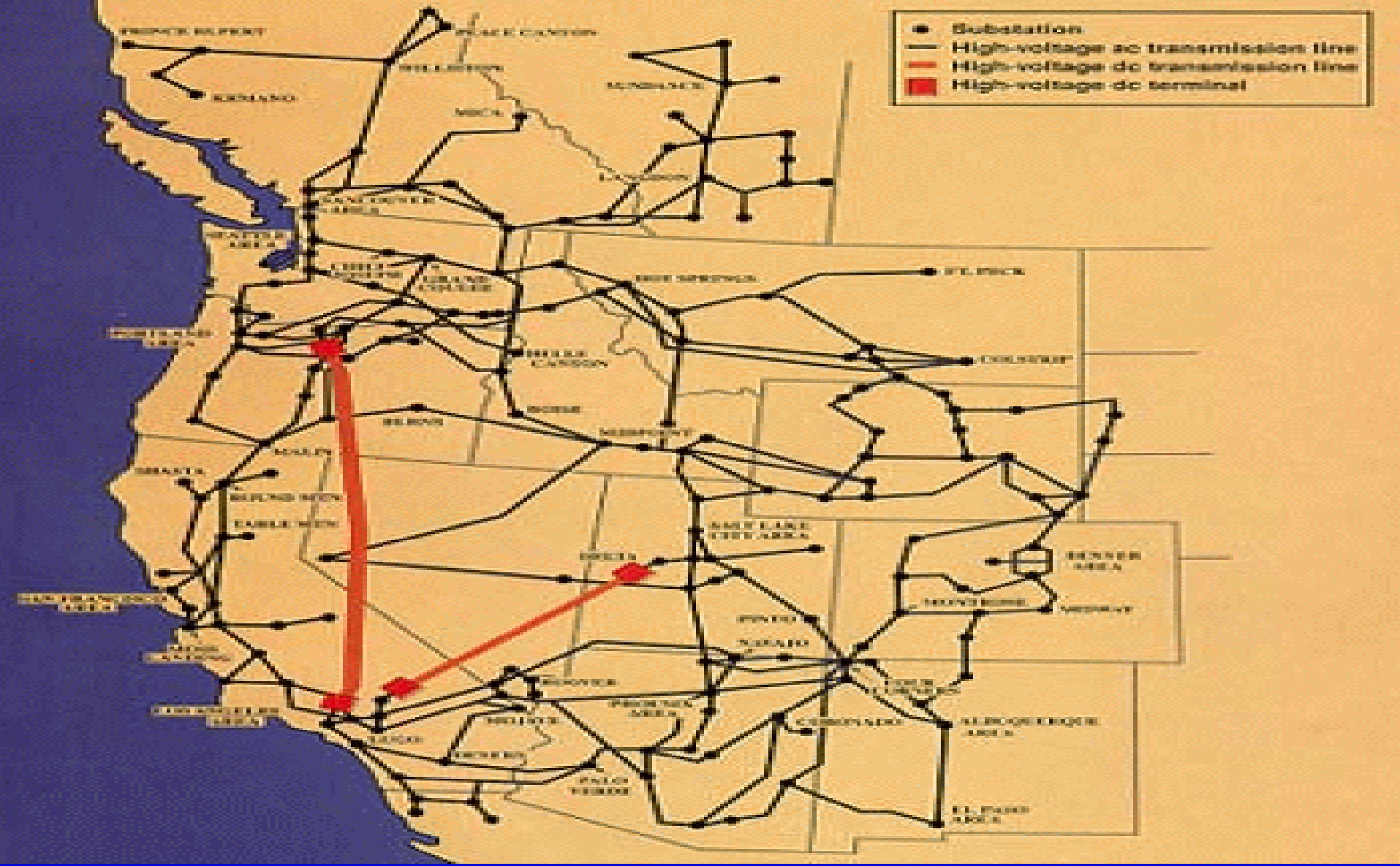
Available Resources

History

A power plant in every neighborhood



Centralize



The Western Interconnection- the “largest machine on Earth”

But then,
the unexpected…….


Decentralize Decentralize Decentralize Decentralize

from
Small is Beautiful

to
Small is Profitable


PBS COMPUTER NETWORK CENTER

Technology

Ready…

Set…..

Not quite…

DER Technology Portfolio

Advanced Turbines

Reciprocating Engines

Fuel Cells

Photovoltaics

Wind

Thermally Activated Technologies

Microturbines

What if this microturbine operated at 40% efficiency?

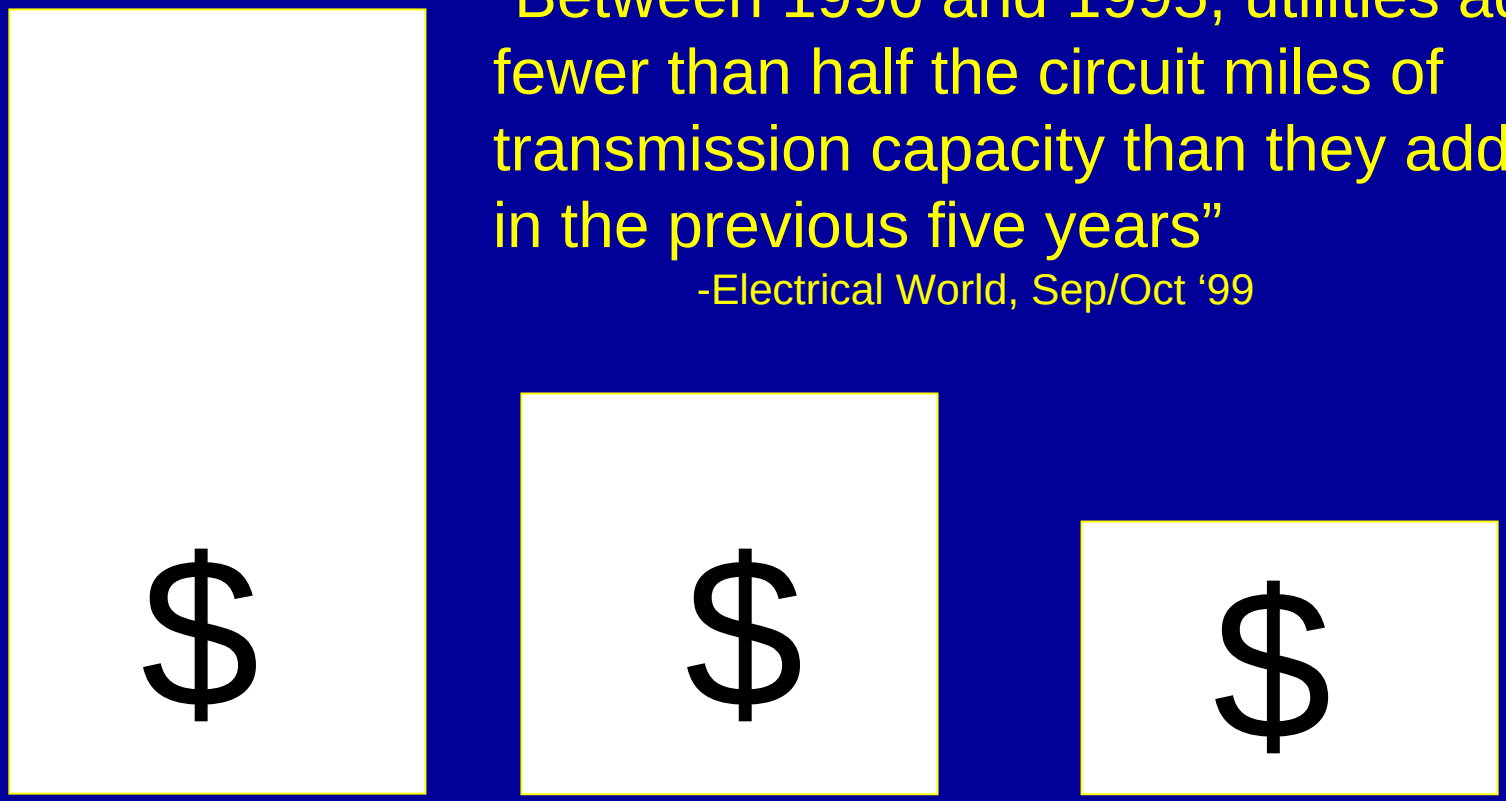
What if these were 30% efficient and cost $1/watt?

What if one $5000 fuel cell powered your car and your home?

What if utility investment in transmission continues to decline?

"Between 1990 and 1995, utilities added fewer than half the circuit miles of transmission capacity than they added in the previous five years"

-Electrical World, Sep/Oct '99



What if a revived New Economy demands more on-site power?

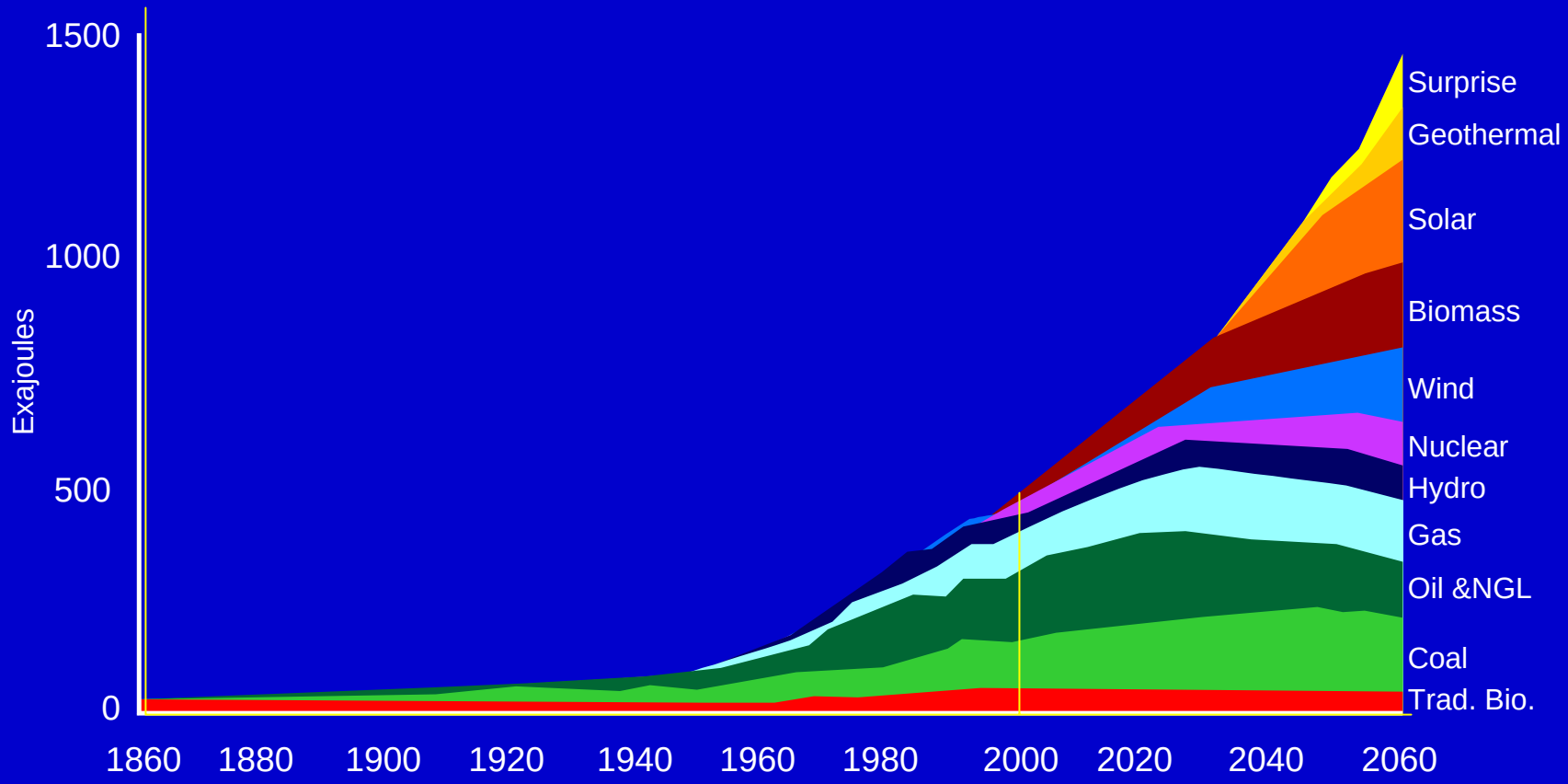
A 100,000-square-foot Web-hosting center built by Exodus Communications consumes enough electricity to power 100,000 homes.

Mobile phones use about three times the amount of electricity that normal phone lines do because they operate by bouncing signals off of base stations.

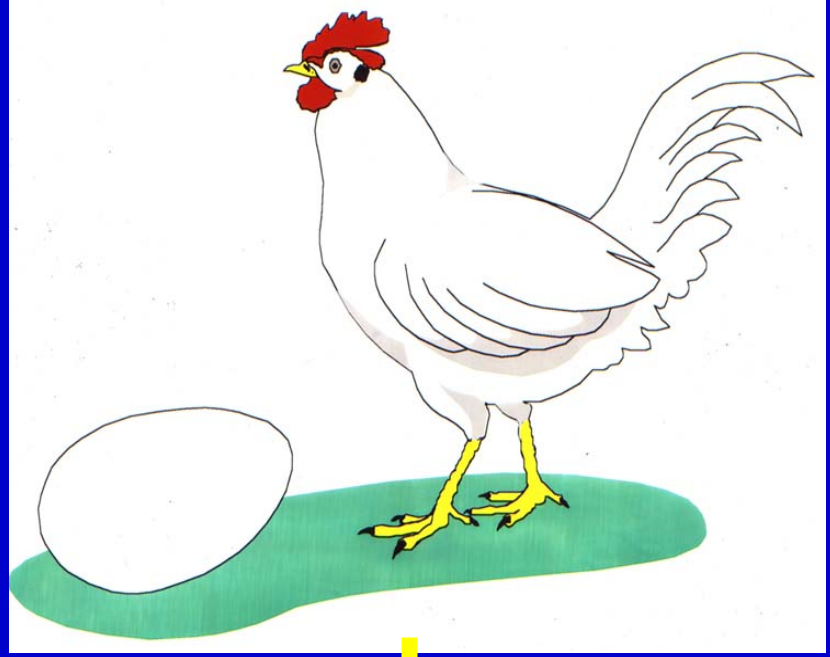
San Jose Mercury News --January 5, 2001

What if we have a return to this?

Or what if Shell Oil knows something about the future….



Source: *Shell, The Evolution of the World's Energy Systems*, 1995



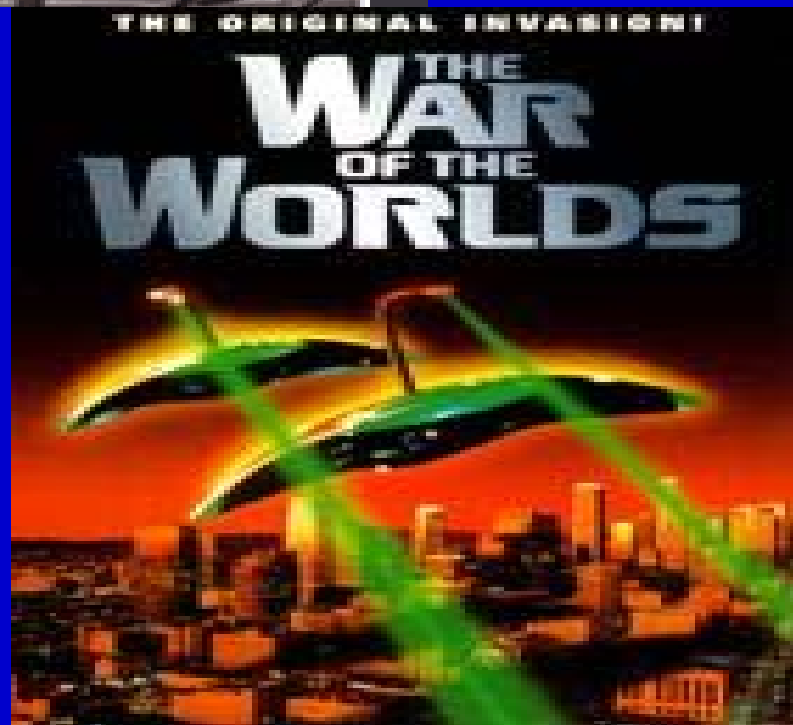
If we ever hope to change the "what ifs" into reality, we must first address and change DER policies and DER R&D strategies.

No! Why bother? I'll pay attention when DER is cost-effective!

If early adaptors want to maximize the DER value proposition, they will want to sell excess power to the grid

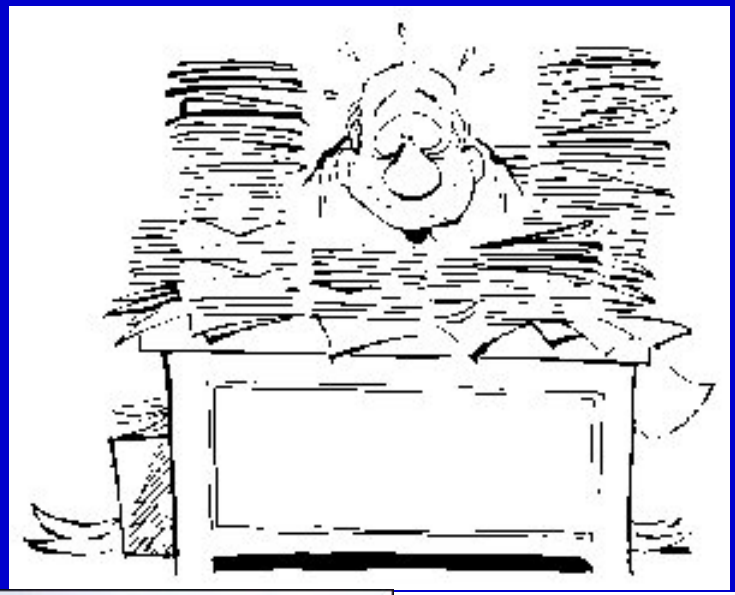
A stable DER business environment wants this...

But often it seems what we have is……..



When customers state that they want to self-generate and connect to the grid…..

…they are greeted by this



And at times, customers feel like this….

Definitions

Distributed Energy Resource and Interconnection

DER is defined as small-scale electric generators located next to and connected to the load being served.

The generator may be stand alone or **interconnected** to the grid.

Definition

Simply put, interconnection refers to the technical, contractual, rates and metering issues that must be settled between the system owner and the utility and local permitting authorities before the system is connected to the grid.

The most common use of DG is for backup power whenever the normal source of electricity fails.

Building Standards Codes require that standby or emergency power systems serve specific types of equipment within specific types of building.

Some customers install optional standby power generators and uninterruptible power supplies.

These DG systems serve electric loads which, if cut off from the normal power supply, could cause discomfort, serious interruption of a process, or damage to the product or process.

DG can be used as a primary source of electricity, essentially reducing or even eliminating reliance on the utility for electric service.

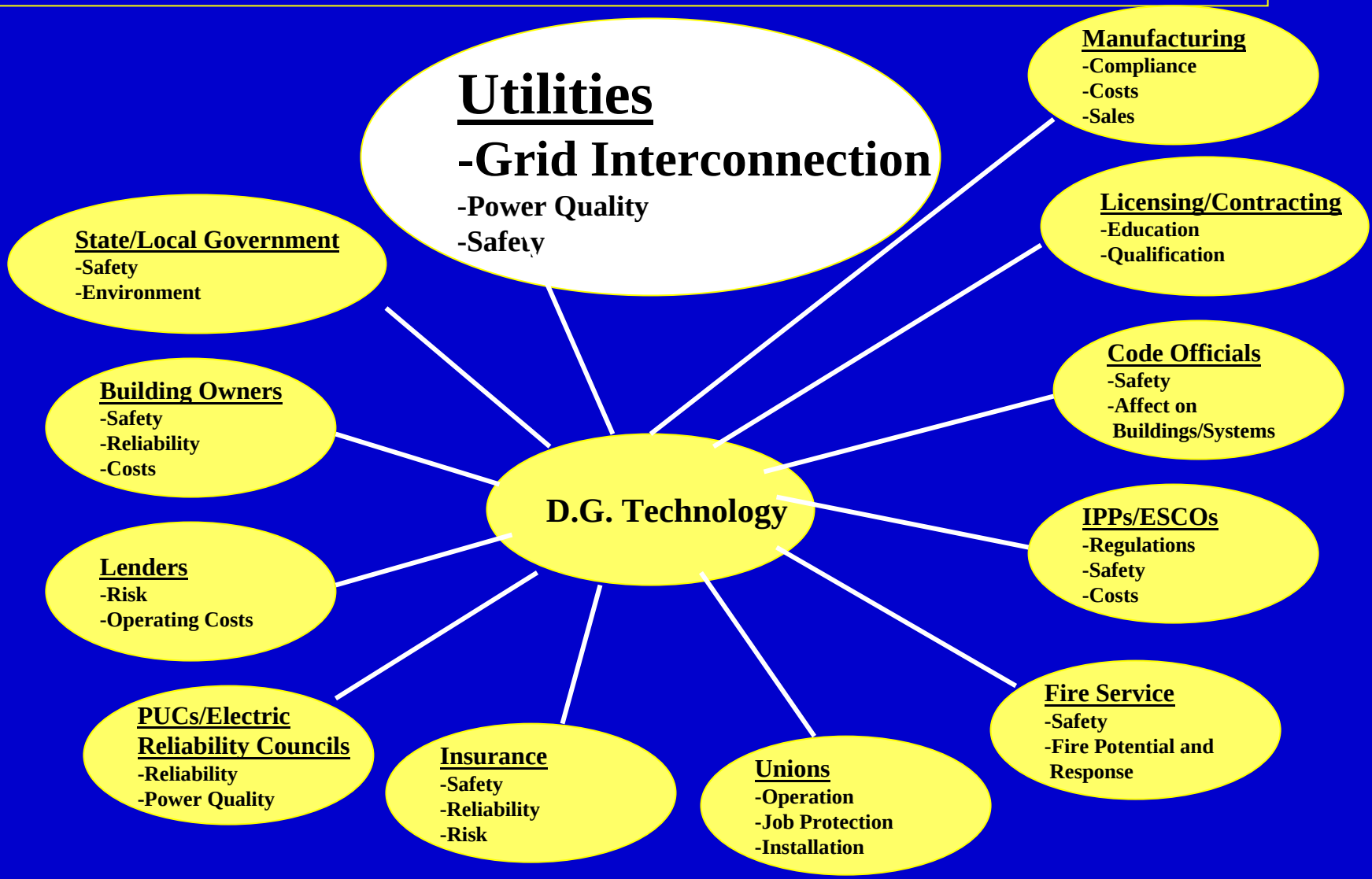
DOE's Strategic Vision for Distributed Energy Resources

- We will have the cleanest, most efficient, and reliable energy system by maximizing the use of affordable distributed energy resources.
- Industrial, commercial, institutional, and residential customers will be able to choose from a diverse array of:
  - ultra-high efficiency, ultra-low emission energy products
  - fuel-flexible, cost-competitive distributed energy services.
- DER will be operated in an optimized manner to maximize value to users and energy suppliers while protecting the environment.

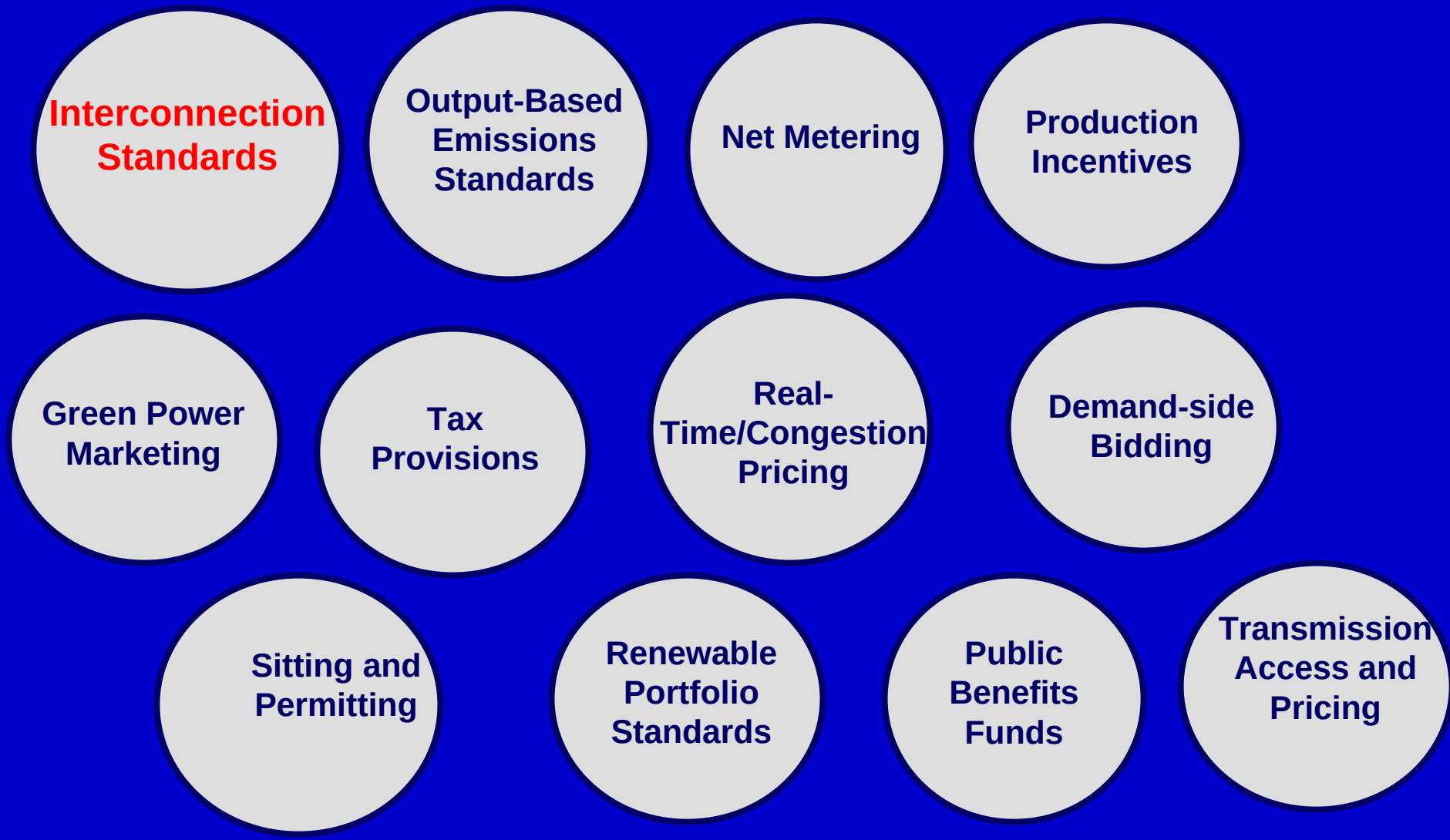
DOE's Strategic Vision for Distributed Energy Resources

- **The systems will be easily interconnected into the nation's infrastructure for electricity, natural gas, hydrogen, and renewable energy resources.**

DER related groups and some issues of concern



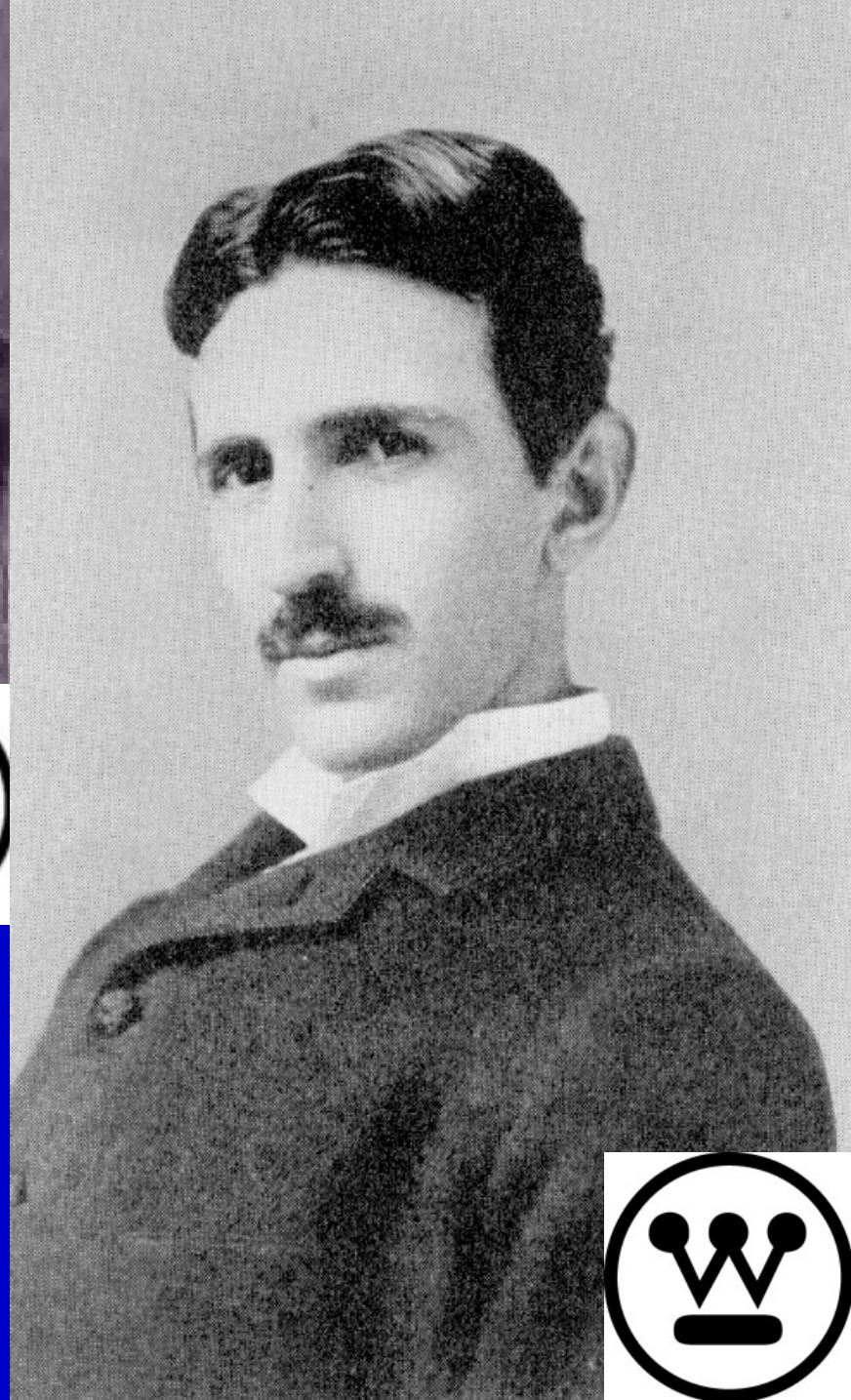
Developing interconnection standards are key to DER's success



The Interconnection Challenge

The Nature of the Problem

These guys didn’t design the electric grid to be two-way.



The electric power system was not designed for Distributed Power Resources

- Utility circuits are typically radial, they were designed for a “ONE WAY” operation.
- Selling power into the grid was not an issue until PURPA (1978).

Tom Casten

Here's a DG advocate that wants to see rapid policy change.

What's the problem?

Utilities' policies and business practices are frequently cited as one of the primary reasons that customers have such difficulty installing interconnected systems.

The utilities defend their sometimes onerous interconnection policies by explaining that they are required, by governing organizations such as utility commissions and boards, to uphold the safety and reliability of the grid.

What's the problem?

Because many utilities have limited experience dealing with small customer-owned generation systems, there is a tendency for utilities to rely on their previous experience with larger systems and require additional safety equipment or to review interconnection proposals on a case-by-case basis in the absence of clear rules.

What's the problem?

All of this points to the need for interconnection standardization for smaller systems. Standardization benefits all concerned parties – equipment manufacturers, end users, utilities, and regulators.

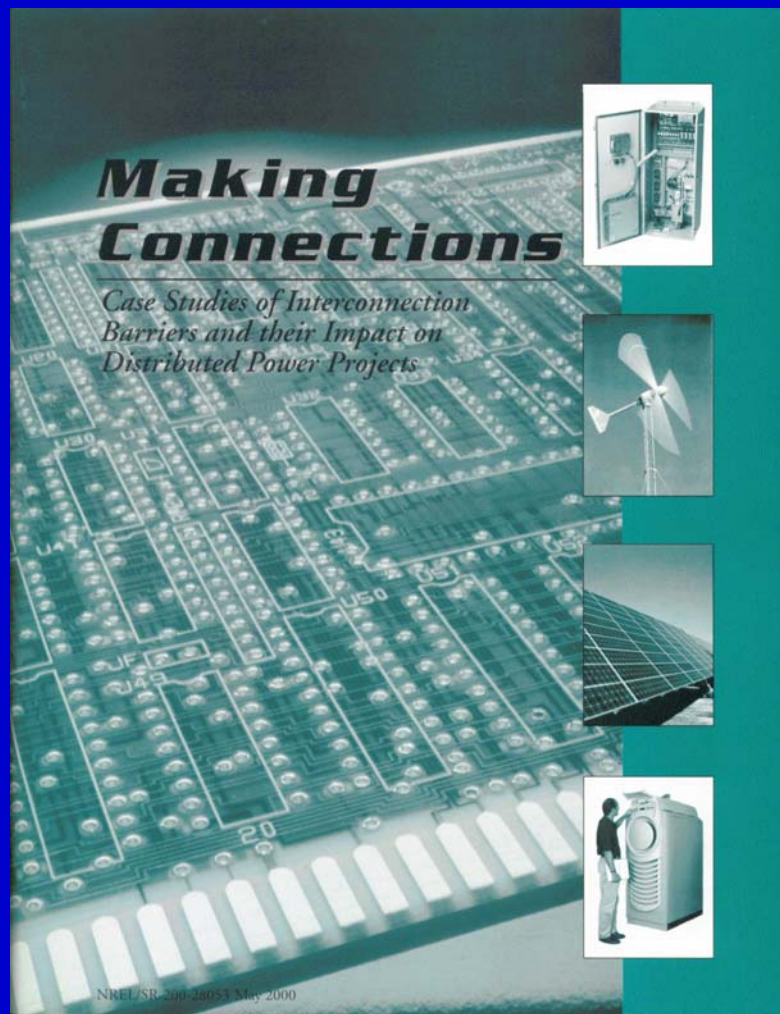
And, this is where recent efforts have been directed.

Identifying the Barriers

Making Connections

Produced by NREL - May, 2000

- **65 case studies of barriers and their impact on distributed generation projects**
- **Project size ranged from 1kw to 25MW**
- **Technologies included photovoltaics, wind, fuel cells, gas turbines and engines**
- **Cases studies from 20 states**



Study Results

- Interconnection requirements vary from state to state and from utility to utility.
- Engineering studies and additional protective relays and breakers are often required.
- Compliance with interconnection requirements could cost $2,000 - $40,000 or more.
- Project delays of up to 6 months or more were experienced.
- Customers can face steep back-up charges or exit fees.

"Making Connections" Action Plan

- **Reduce Technical Barriers**
  - Adopt uniform technical standard for interconnecting distributed power to the grid
  - Adopt testing and pre-certification procedures for DG equipment
  - Accelerate development of distributed power control technology and systems

"Making Connections" Action Plan

Reduce Business Practice Barriers

– Adopt standard commercial practices for any required utility review of interconnection

– Establish standard business terms for interconnection agreements

– Develop tools for utilities to assess the value and impact of distributed power at any point on the grid

"Making Connections" Action Plan

Reduce Regulatory Barriers

- Develop new regulatory principles compatible with distributed power choices in both competitive and utility markets
- Adopt regulatory tariffs and utility incentives to fit the new distributed power model
- Establish expedited dispute resolution processes for distributed generation project proposals
- Define the conditions necessary for a right to interconnect

Addressing the challenge

Distributed Energy: Towards a 21st Century Infrastructure

Published July 2001 after 2 years of meetings, analysis, and drafting by 85 key stakeholders from across the United States.

The effort was undertaken by the Consumer Energy Council of America (CECA) "the nation's senior public interest organization focusing on the energy, telecommunications, and other network industries providing essential services to consumers."

CECA

As an organization dedicated to identifying and promoting policy initiatives that benefit consumers, CECA convened the Distributed Energy Domestic Policy Forum as a meeting place for diverse views of state and federal government, industry, utilities, non-governmental organizations, consumers, and environmentalists. The goal was a thorough discussion of the many technological, regulatory and business issues that must be addressed to effect the major change implied by large-scale deployment of distributed energy resources.

CECA believes that distributed energy, when properly integrated with an improved national electric power system, incorporated into the economic structure, and accommodated by appropriate regulatory and administrative regimes, has the potential to benefit significantly consumers by leading to:

- Lower cost electricity and higher net energy efficiency;
- Enhanced end-user energy source and design choices;
- Improved overall system reliability;
- Enhanced environmental quality;
- Improved power quality and reliability for specific consumer needs, particularly in the digital economy; and
- A new platform for integrated consumer services involving the convergence of electricity, natural gas, and telecommunications grids.

CECA

These benefits may be realized while simultaneously advancing a number of public goods, such as lessening the environmental impact of energy production and use, permitting flexible strategies to meet anticipated significant increases in demand, promoting equity for consumers, and ensuring market access for new supplies.

CECA

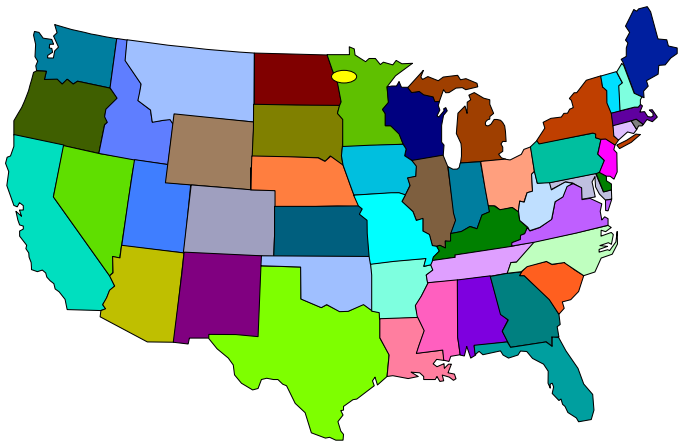
CECA recognizes the significant challenges and concerns that must be addressed if the potential of DE is to be fully realized. Addressing these concerns is central to developing a successful strategy for distributed energy. The confluence of technology development, electricity sector restructuring, and evident need for relieving supply and transmission constraints provides an exceptional opportunity over the next few years to focus on and work towards a 21st Century power infrastructure.

CECA

CECA believes that the time has come for a concerted effort to move toward greater reliance on DE to meet our burgeoning energy needs.

An expanded role for DE resources will require a new design and management approach toward traditional transmission and distribution facilities. The transition will be complex and will take extended time to implement. If DE resources are to achieve their potential in reducing or resolving those constraints, time is of the essence.

Q: How to address a patchwork of policies, technologies?



A: Construct platforms for consistency

IEEE

Institute of Electrical and Electronics Engineers

Interconnection Standards are under development at IEEE

In March 1999, the Institute of Electrical and Electronics Engineers (IEEE) Standards Association Board voted to undertake the development of uniform standards for interconnecting distributed resources with electric power systems. The IEEE Standards committee is now responsible for developing technical standards for distributed technologies.

Interconnection Standards are under development at IEEE

The consensus standard will contain specific requirements related to performance, operation, testing, safety, and maintenance of interconnections between distributed resources and other electric power systems.

The U.S. Department of Energy (DOE) is funding IEEE to develop the standard on an accelerated schedule of two to three years—about half of the time period usually required.

IEEE Interconnection Standard P1547

- **Title: Standard for Interconnecting Distributed Resources with Electric Power Systems**
- **Scope:** This standard establishes criteria and requirements for interconnection of distributed resources (DR) with electric power systems (EPS).
- **Purpose:** Provide a uniform standard for interconnection of distributed resources with electric power systems, and requirements relevant to the performance, operation, testing, safety considerations, and maintenance of the interconnection.

National Association of Regulatory Utility Commissioners (NARUC)

Regulatory Framework

State and local policies and regulations regarding the deregulation of electricity and distributed generation have an effect on the installation and financial feasibility of DER.

Restrictive permitting or long delays in obtaining permits can dissuade building owners from installing DER.

High exit and/or interconnection fees, and standby electric rate structures can be financial disincentives for DER.

Regulatory Framework

Some States, such as Texas, have made progress to set policies that are DER friendly such as promoting standard interconnection requirements and fees, and setting reasonable goals for time limits on studies.

As more States recognize that DER becomes an integral part of the electrical infrastructure, policies and regulations should support DER becoming the "preferred system" for buildings.

Access and Interconnection Policies and Requirements

Many States have no standard, policies and requirements for Access and Interconnection. In those States it is left up to each individual electric utility to define the procedures that affect DG installations.

Each utility has an approved rate structure and its own guidelines that must be followed when installing DG/CHP within that electric utility's service territory.

Access and Interconnection Policies and Requirements

This results in a "hodge-podge" of rules, standards, and fees makes it difficult for manufacturers, engineering and installation companies, energy service companies, and other that want to install DER at several sites within a State to discern what the requirements and subsequent cost will be.

The financial aspects for the same DER installation in one service territory will likely be very different than in another.

Access and Interconnection Policies and Requirements

Many States have begun working towards identifying appropriate interconnection standards for connecting to utility distribution systems; some such as Texas and Michigan have completed guidelines.

Some States are working on developing their own interconnection standards, often soliciting developmental guidance from utilities within their State, others are proposing to follow the requirements set forth in the developing IEEE 1547, *Standard for Distributed Resources Interconnected with Electric Power Systems.*

Access and Interconnection Policies and Requirements

Utilities generally require an interconnection study to be completed. In addition to the cost of the study, this process also often adds time to the projects duration, sometimes months while the utility completes and reviews the study.

Access and Interconnection Policies and Requirements

Generally these studies are required to be done by the utility itself and the fees vary widely depending on the type of equipment being installed, the location of the connection on the grid, and the utility. These studies can be very costly and often cost prohibitive to smaller installations.

Some utilities have simplified study processes for grid interconnections if the DG source is below a certain size- say 30 to 40 kilowatts.

Utility Rate Structures

Many utilities have rate structures that serve as a disincentive to installing DG and CHP. These rate structures carry high standby demand charges, often based on worst-case scenarios depicting the need to maintain capacity to supply DG installation during the highest peak demand.

Utility Rate Structures

They also carry penalties associated with electric usage during unplanned outages of the customer's generation equipment. The variation in utility rate structures makes the financial viability of a DER installation very sensitive to the utility area it is in, as well as how the operating performance of generation portion of the system performs.

Utility Rate Structures

Another circumstance that impacts the financial viability of DER is the potential for re-negotiated discounted rates to those customers who intend to self-generate.

Many States allow for the utility to re-negotiate rates when the potential loss of a customer would result in an uneconomic bypass of the utility's system.

Utility Rate Structures

This can occur when the customer has decided to investigate or move forward with a DG or CHP installation. A customer may have already paid a consulting firm to review the rate structure and likely savings and/or paid an engineering firm to develop a specification for the DER installation.

The project can have a reasonable payback and good economics, yet because the host electric utility does not want to lose the electric load, they offer a lower rate. This can effectively stop the installation.

Exit Fees

In many States exit fees are determined by the utility on a case-by-case basis and can vary significantly and be relatively substantial.

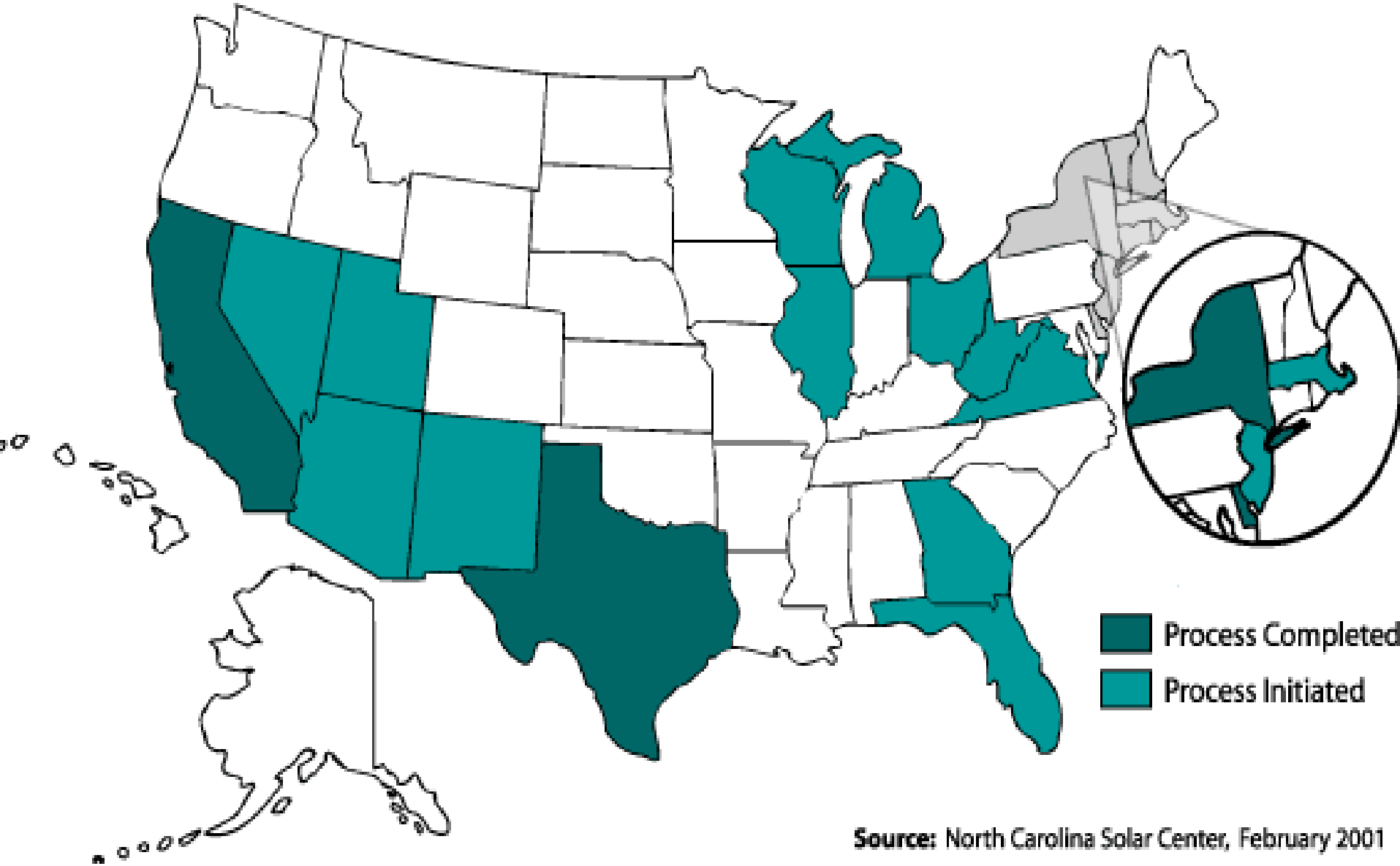
For smaller projects, exit fees can be a disincentive to installing DER.

State Regulatory Activities

While national standards are being developed, state regulations are also addressing interconnection issues. The state regulations typically address customer access to the grid, technical issues of interconnection to the grid, insurance issues, pricing for power sold back to the grid, acceptable utility charges related to interconnection, and utility planning considerations.

Status of State Distributed Resource Regulatory Activity

Click on state below to view activity details.



Source: North Carolina Solar Center, February 2001

State Regulatory Activities

In response to these many problems and opportunities, the National Association of Regulatory Utility Commissioners has become active on the topic in the past few years.

But the association has no authority to require change, it is advisory. Each PUC is free to move at its own pace.

National Association of Regulatory Utility Commissioners

DER Interconnection Agreement &Procedures

- NARUC Resolution, 2001
  - Reviewed NARUC's long and consistent support for DER
  - Endorsed the development of DER "Interconnection agreement and procedures"
  - Agreed to build upon work begun in leading states

A new NARUC publication:

Model Distributed Generation Interconnection Procedures and Agreement
July 2002

58 pages
Voluntary policy guidance for state PUCs

Funded by the U.S. Department of Energy's
Office of Distributed Energy Resources
through the National Renewable Energy Laboratory

available at:
http://www.naruc.org/Programs/dgia/dgiaip.pdf

State Regulatory Activities

See the following Web sites for state-by-state information:

- Status of state distributed resource regulatory activity — From DOE's Distributed Power Program.
- State-by-state interconnection table — From the Interstate Renewable Energy Council.

California

- Now has on-line interconnection application procedures for distributed generators within the Southern California Edison and San Diego Gas & Electric service areas. Posted on the California Energy Commission's distributed generation Web page.

Plug and Play

Plug and Play

Designing plug-and-play systems for DER systems is critical to reducing the time and effort required to integrate system components. Universal connection standards would greatly simplify installation and maintenance-and encourage acceptance of the technology by the architectural and engineering community.

Plug and Play

Simplified, pre-engineered, skid-mounted DER equipment would make building owners responsible only for connecting power, piping, or ducting. Controls may be connected to a local network, permitting on-site personnel to operate the equipment directly from a desktop PC.

Here’s some State DER news

State News

New York PSC Approves Xantrex SW Series Inverters with Grid Tie Interface

Wisconsin Collaborative Continues Interconnection Discussions, Next Meeting August 20

NARUC Releases Model Procedures for Interconnection of Distributed Generation

Vermont Passes Unique Net Metering Provision for Farm-based Groups

Arkansas PSC Issues Net Metering Order

NARUC Floats Interconnection Proposal for Comment

Here’s some national DER news

National News

FERC Issues ANOPR on Small Generator Interconnection

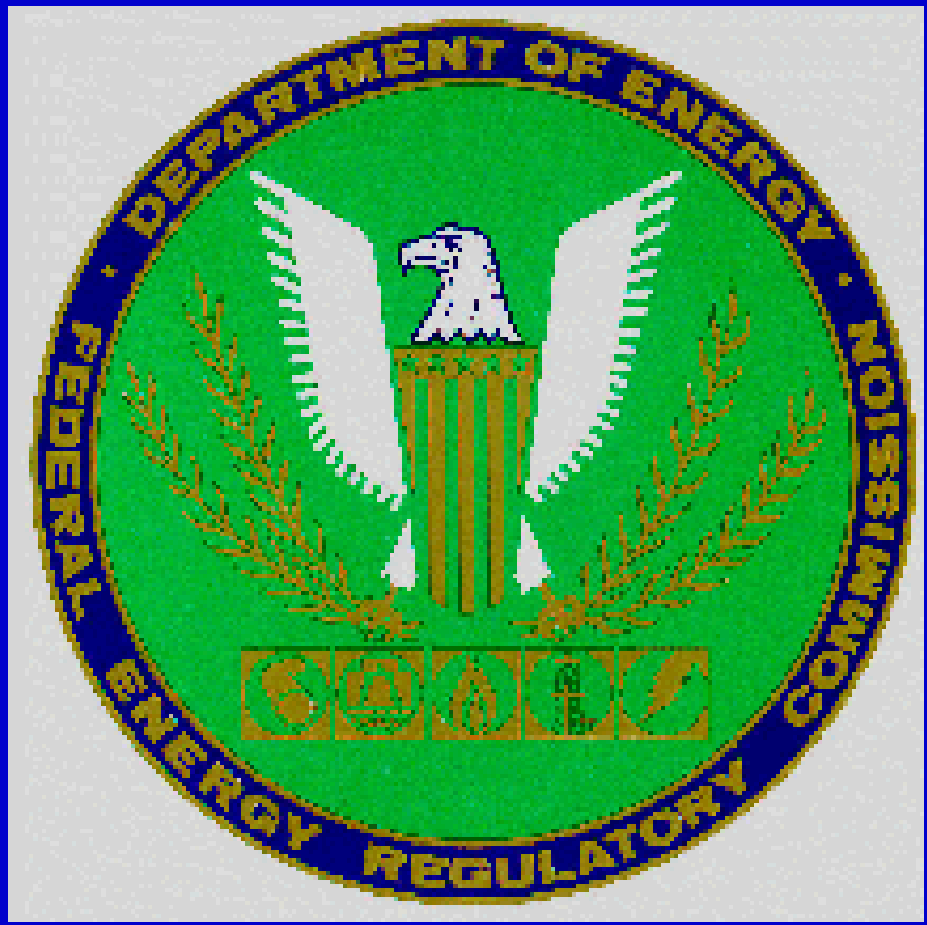
FERC Releases Standard Market Design Plan

NARUC Releases Model Procedures for Interconnection of Distributed Generation

GAO report presses FERC to adopt Texas transmission model

SMA receives UL Listing for 1800 Watt string inverter

Federal Energy Regulatory Commission



FERC Issues ANOPR on Small Generator Interconnection

On August 16, 2002, the Federal Energy Regulatory Commission issued an Advance Notice of Proposed Rulemaking (ANOPR) on a proposed national standard for the interconnection of small generators. The Rulemaking would apply to any generator that will participate in a FERC regulated market, sell power for resale in interstate commerce or is interconnected to a FERC regulated transmission line.

The ANOPR is targeted at developing consensus among interested parties for a national standard applying to two categories of small generators – those below 2MW in size, and those from 2-20MW.

FERC Issues ANOPR on Small Generator Interconnection

Parties are expected to file joint comments on November 4, 2002. FERC anticipates it will issue a Notice of Proposed Rulemaking on small generator interconnection before the end of the year, with the expectation that a final rule will be issued in March 2003.

The ANOPR uses as a starting point almost the exact detailed rules and guidelines suggested by the Solar Energy Industries Association and the US Fuel Cells Council for generators less than 2MW.

FERC Issues ANOPR on Small Generator Interconnection

These guidelines were largely based on the distributed generation rules already in place and working in Texas and ERCOT. For the larger systems (2-20MW), the FERC indicated it was considering adopting the rules and guidelines submitted by the Combined Heat and Power Association which were based in large part on the expedited Small Resource Rules used by the PJM independent grid operator.

FERC Issues ANOPR on Small Generator Interconnection

Both groups suggested their guidelines in comments to the FERC on a separate NOPR for generator interconnection last June. If the guidelines as presented are included in the file rules the FERC issues, it would be a major step forward for a single national distributed generation interconnection standard. The proposed rules are based on the simple fundamentals of pre-certified generators ready for “plug and play” operation.

FERC Issues ANOPR on Small Generator Interconnection

A simple standard form agreement was included in the ANOPR and for simple interconnections, fees would be small or none. Interconnections would be approved within 15 days of application unless the interconnecting utility applied to the FERC for a case by case waiver.

FERC Issues ANOPR on Small Generator Interconnection

While the rules would only have direct applicability to FERC regulated generators, it would be of immense persuasive value for states that are developing their own interconnection rules. In addition, as FERC expands its activities under standard designs for wholesale markets, it will undoubtedly create new opportunities for even residential sized systems to participate in load response and other economic incentive programs developed to help customers address their electricity needs through a broader array of competitive options.

FERC Issues ANOPR on Small Generator Interconnection

In many states, customers would have the option of interconnecting their generator under either state or federal rules. The ones friendliest to the generators would prevail. Discussions on the ANOPR began with public meetings at the FERC on September 9th and 10th.

National Standards – Good News!

UL Standard 1741

Title: Inverters, Converters, and Controllers for Use in Independent Power Systems

This standard from the Underwriters Laboratories Inc. (UL) covers inverters, converters, charge controllers, and output controllers intended for use in stand-alone or grid-connected power systems.

UL standards aim to minimize the risk of fire or of electric shock or injury to persons from electrical components.

National Standards - More Good News!

National Electrical Code, NFPA 70

The National Fire Protection Association (NFPA) sets national standards for the installation of electrical equipment. NFPA 70, the National Electrical Code, provides "practical safeguarding of persons and property from hazards arising from the use of electricity."

DER Information Resources

Federal websites

Department of Energy – Federal Energy Management Program (FEMP)
http://www.eren.doe.gov/femp

Department of Energy – Distributed Energy Resources Program
http://www.eren.doe.gov/der

Department of Energy – Regional Office Representatives
http://www.eren.doe.gov/rso.html

FEMP Design Assistance Program
http://www.eren.doe.gov/femp/techassist/designassist.html

FEMP Energy Saver Showcase Program
http://www.eren.doe.gov/femp/prodtech/get_recogniz.html

FEMP SAVEnergy Program
http://www.eren.doe.gov/femp/techassist/savenergyprog.html

FEMP Renewable Energy Resources
http://www.eren.doe.gov/femp/techassist/renewenergy.html

Energy Information Administration
http://www.eia.doe.gov

Federal Incentives for Commercial Solar Applications
http://www.mdv-seia.org/federal_incentives.htm

FEMP *Guide to Greening of Federal Facilities*
http://www.eren.doe.gov/femp/greenfed

FEMP *Handbook for Promoting Behavior-Based Energy Efficiency in Military Housing*
http://www.eren.doe.gov/femp/yhtp/strategies.html

Department of Energy – Office of Power Technologies
http://www.eren.doe.gov/power/

U.S. Environmental Protection Agency
http://www.epa.gov

Industry and other websites
Alliance to Save Energy
http://www.ase.org/

American Wind Energy Association
http://www.awea.org

Association Council for Energy Efficient Economy
http://www.aceee.org

Distributed Power Coalition of America
http://www.distributed-generation.com/dpca/

Edison Electric Institute
http://www.eei.org

Electricity Storage Association
http://www.electricitystorage.org/

Energy-efficient Product Information
http://www.energystar.gov

Fuel Cell Developers
http://216.51.18.233/fcdevel.htm

Institute of Electrical and Electronics Engineers
http://www.ieee.org

National Association of Regulatory Utility Commissioners
http://www.naruc.org

Online Fuel Cell Information Center
http://www.fuelcells.org

Public Technology, Inc.
http://pti.nw.dc.us/index.html

Solar Buzz
http://www.solarbuzz.com

Solar Energy Industries Association
http://www.seia.org

United States Fuel Cell Council
http://www.usfcc.com

DER and Interconnection References

- **FEMP DER Program**
  http://www.eren.doe.gov/femp/techassist/der_resources.html
- **DOE DER Office**
  http://www.eren.doe.gov/der/
- **DOE/NREL Distributed Power Program**
  http://www.eren.doe.gov/distributedpower/
- **NARUC Feb 2002 Resolution Endorsing the Development of Model Interconnection Agreement and Procedures**
  http://www.naruc.org/Resolutions/2002/winter/elec/model_interconnection.html
- **FERC Generation Interconnection Activities**
  http://www.ferc.fed.us/electric/gen_inter.htm

FEMP-sponsored DER Reports

"How-to" Guide for Federal Energy Managers

Available on the FEMP website:
www.eren.doe.gov/femp

DER Guide

Available on the FEMP website

50-page Federal DER Markets Assessment

contact Morey Wolfson

Upcoming FEMP-sponsored DER workshops

Regional Workshops:

- Boston, October 23-24, 2002
  - See the FEMP website
- Los Angeles: Spring, 2003
  - See the FEMP website for announcement
  - Contact the Seattle DOE Office

Thank you.
Time for questions?