United States Country Report - DG, RES, DR/DSM Draft

Policies, driving forces for DG, RES, DR/DSM

DSM In the United States - Background [1]

There are three kinds of demand side management efforts in the United States – those that are formally undertaken by electric utilities, those that emerge as a result of government action (such as building and energy code requirements), and those that result from vendor and consumer interests that build sales of more energy-efficient products. This report will focus primarily upon utility and government policy-driven DSM (in what will be termed, "programs"), but market- and consumer-driven efforts also have a significant effect upon U.S. electricity use.

Utility demand-side management (DSM) programs consist of the planning, implementing, and monitoring activities of electric utilities that are designed to encourage consumers to modify their level and pattern of electricity usage. DSM refers only to energy and load-shape modifying activities undertaken in response to utility-administered programs. It does not refer to energy and load-shape changes arising from the normal operation of the marketplace or from government-mandated energy-efficiency standards.

Although utility DSM was strong in the 1970s and '80s, it lapsed in the 1990s as electricity supplies appeared plentiful and utilities and policy-makers made industry restructuring a higher priority. However, the dramatic rise in energy prices, increasing electricity resource adequacy concerns, growing price volatility, and climate change concerns have all contributed to a renewed interest in DSM of all types. In the past, the primary objective of most DSM programs was to provide cost-effective energy and capacity resources to help defer the need for new sources of power, including generating facilities, power purchases, and transmission and distribution capacity additions. While generation and transmission capacity deferral are still important goals for utility DSM, today additional goals include customer service enhancement, reducing the environmental impact of electricity production and use (particularly the carbon footprint), increasing state and regional energy security, and reducing the utility or state's exposure to high, volatile energy prices.

Current Status

Note: Integration efforts in the U.S. largely look at each technology's integration on Transmission or Distribution level – sometimes integration of two technologies together is considered. There is little work to date on simultaneous integration of DSM, DG, renewable and storage. Plans for simultaneous operational integration of technologies are being considered, for example, by solar and wind energy technology areas.

[1] http://www.eia.doe.gov/cneaf/electricity/dsm99/dsm_sum99.html

There is little detailed information about U.S. utility DSM. The most commonly used aggregated data comes from the U.S. EIA Annual Reports, which show that in 2006 utility DSM reduced peak load by 27,240 MW (from both efficiency and load management) and saved 63,817 thousand MWh. (EIA 2006 Energy Annual, at http://www.eia.doe.gov/cneaf/electricity/epa/epat9p1.html) However, other data sources often conflict with the EIA's conclusions.

Although utility DSM efforts are determined on a state-by-state. utility-specific basis, two broad factors are accelerating the growth of utility DSM. First, in 2006 the U.S. Department of Energy and Environmental Protection Agency, initiated a collaboration with leading utilities, regulators and vendors to reinvigorate energy efficiency for a new generation of organizations and leaders.2 The National Action Plan for Energy Efficiency has now published a series of studies and conducted regional workshops to help explain how and why to do energy efficiency, and more work is underway. To date more than 150 utilities, state regulatory commissions, and other organizations have made and begun executing substantive commitments to initiate or increase energy efficiency for their businesses and customers. Information on the NAPEE can be found

Status and targets for DG, RES, DR/DSM

- Numerous states have renewable energy goals, but there is no national goal today. Approximately 30 states have renewable portfolio standards. See attached map of states with RPS goals (as of June 2007)
- Typical target is 20% by 2020 (see map below)
- Presently there is no national rule for DG/Renewables. However, there is an active group of legislators that is pushing for legislation.

at www.epa.gov/solar/energy-programs/napee/index.html .

The second factor motivating additional DSM is the Energy Independence and Security Act of 2007. This new law responds to concerns about energy security, high prices and climate change concerns by mandating energy efficiency improvements for a variety of building types, appliances and transportation. (See details on the expected energy savings impacts of the EISA at http://aceee.org/energy/national/07nrleg.htm .) Although the Act does not directly mandate additional utility DSM, it allows utility programs to leverage and expand those efficiency improvements through utility programs. Details on the new standards requirements in the EISA can be found at http://www.standardsasap.org/documents/EISA_stdrds_detail.pdf ; information on state appliance and buildings standards is available at http://www.standardsasap.org/state.htm.

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[2] http://www.epa.gov/cleanrgy/actionplan/eeactionplan.htm

Demand Response

- Growing use across US, but still less than 1% of total peak load
- More use of DR in areas with regional grid operators (PJM, NYISO, ISO-NE), up to 5% of peak load.
- DR more widespread as emergency load relief than as price-responsive load
- DR success depends largely upon regional market structure and ease of getting real-time wholesale electricity price information and time-sensitive retail electric rates; also availability of advanced meters
- DR success also reflects compensation scheme, especially payments for capacity v. energy

Distributed Energy[3]

Distributed energy offers solutions to many of the United State's most pressing energy and electric power problems, including blackouts and brownouts, energy security concerns, power quality issues, tighter emissions standards, transmission bottlenecks, and the desire for greater control over energy costs. However, without significant incentives and subsidies, distributed renewables in particular are not cost-effective against delivered retail electricity prices for most customer applications.

The primary organizations funding distributed energy research are the federal government, the states of California and New York, a few utilities, and technology vendors. The U.S. Department of Energy's Distributed Energy Program supports cost-effective research and development aimed at lowering costs, reducing emissions, and improving reliability and performance to expand opportunities for the installation of distributed energy equipment today and in the future. Program activities are focused on:

(1) Distributed technologies - small-scale, modular technologies for on-site, grid-connected or stand-alone energy conversion and delivery.

- Gas-Fired Reciprocating Engines
- Industrial Gas Turbines
- Microturbines
- Technology-Base Research
- Thermally Activated Technologies

(2) integrated energy systems - Systems that combine distributed power generation with equipment that uses thermal energy to improve overall energy efficiency and fuel use.

- CHP Applications
- CHP Technologies

[3] http://www.oe.energy.gov/randd/distributed_energy.htm

With respect to applications, the most widely deployed distributed resources (in the <20 MW size range) in the U.S. are small diesel generators used for back-up generation, photovoltaic panels used for home and remote generation, and small combined heat and power units used in commercial and industrial applications. Many DG technologies are mature but most are not yet commercially available and competitive. Changing fuel prices and emissions concerns are affecting the relative desirability and acceptability of competing DG technologies – for instance, tightening emissions standards are driving a push for more efficient, natural gas-fired reciprocating engines for use to replace diesel-powered back-up generators, and encouraging the use of solar photovoltaics and small-scale wind technologies as well. However, diverse state-specific interconnection rules and widely varying wholesale and retail market regimes (as well as the absence of national incentives or procurement policies) are slowing the deployment of DG relative to its pace in other nations.

Renewable Energy Systems [4]

Federal & National Assistance

There are many federally supported programs to development and utilization of renewable energy systems. Some of those programs are detailed in the following paragraphs.

Energy Policy Act of 2005 Tax Credits
A State Energy Conservation Office (SECO) web page offering several articles on the Energy Policy Act of 2005 Tax Credits.

Funding Opportunities
This SECO web site lists national funding opportunities for energy efficiency, energy conservation and renewable energy projects and initiatives.

Ethanol Incentives
This is a SECO page that lists federal incentives for ethanol.

DOE Financing Solutions & Incentives
Provides useful links to energy efficiency and renewable energy financing resources for homeowners, small business, industry, utilities, state and local programs, federal building, and international projects.

SEIA Guide to Federal Tax Credits for Solar Energy
To help homeowners take advantage of the federal solar energy tax credits, the Solar Energy Industries Association (SEIA) has published "The SEIA Guide to Federal Tax Credits for Solar Energy," a 40-page manual in the form of a 1.4-MB PDF file. See the **SEIA press release** and **sign up on the SEIA Web site** to receive a free copy of the guide via email.

Incentives for Geothermal Heating and Cooling Systems
A Geothermal Heat Pump Consortium web site.

[4] http://www.infinitepower.org/incentives.htm#federal

ENERGY STAR
Energy Star offers businesses and consumers energy efficient solutions - helping to save money while protecting the environment for future generations. Energy Star is a voluntary labeling program of the U. S. Environmental Protection Agency and the US Department of Energy that identifies energy efficient products. Energy Star programs and products help save the environment and save consumers money by using less energy through advanced design or construction.

U. S. Housing and Urban Development — Energy Efficient Mortgage Home Owner Guide
Additional information on the Energy Efficient Mortgage (EEM)

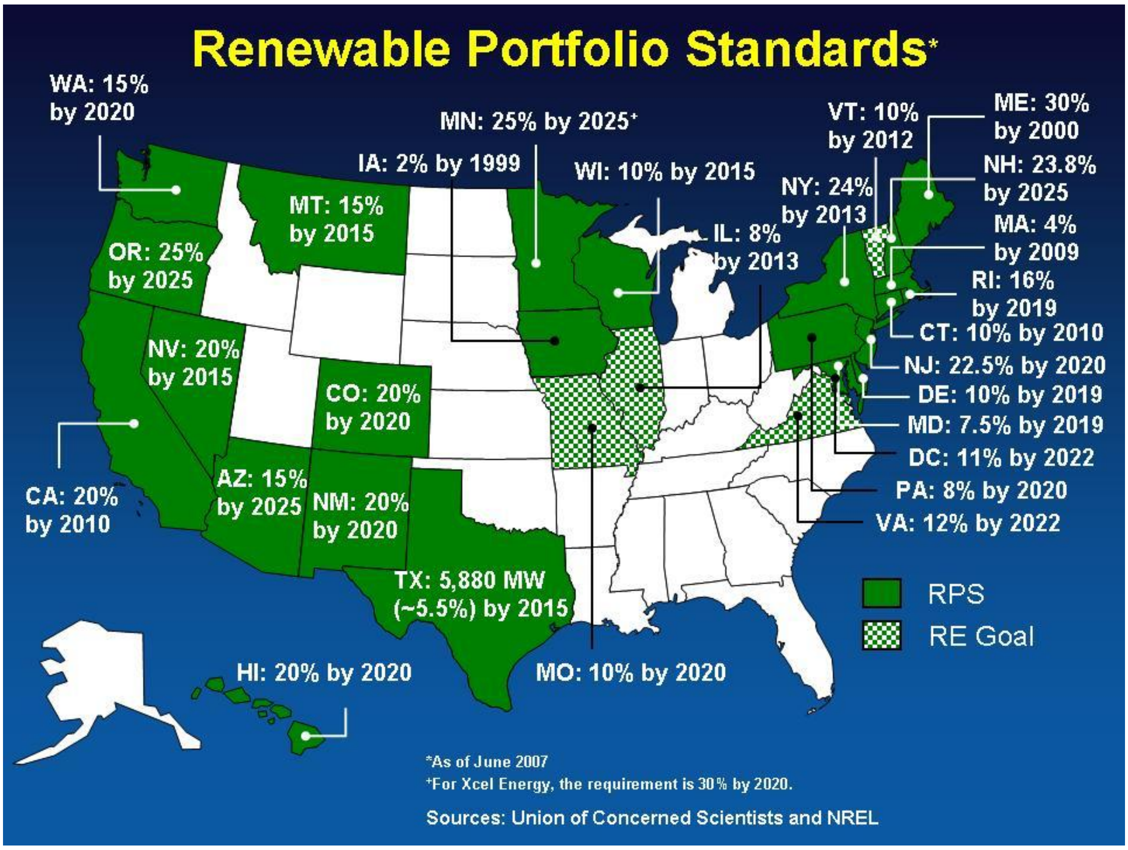
The Borrower's Guide to Financing Solar Energy Systems: A Federal Overview
This U. S. Department of Energy document provides information that can assist both lenders and consumers in financing solar energy systems, which include both solar electric (photovoltaic) and solar thermal systems. The guide also includes information about other ways to make solar energy systems more affordable, as well as descriptions of special mortgage programs for energy-efficient homes.

Market structures

Support schemes and guaranteed price programs vary in each of the U.S. states, and often vary between utilities in those states. If there are mandated programs or Public Utility Commission rules in place in any state, the IOUs will often be the only utilities affected by those rules. Cooperatives generally don't fall under the jurisdiction of the PUCs, and Municipalities (or other government-affiliated utilities) are generally self-governing. In some states, there is legislation in place that often affects all electricity suppliers including IOUs, municipalities, and cooperatives. There are a minimum of 35 states that have net metering and interconnection rules in place which allow owners and users of DG and DR to connect to the grid. Although those states each have unique rules, they generally require that the utility purchase unused energy at wholesale prices. Because all states treat net metering and interconnection in a unique manner, it would require a table to differentiate between them.

In most installations with net metering, the DG customer would consume some of the energy with the remaining energy sold back to the utility. The utility may either credit the customer with the kWh received, or pay the customer on wholesale rate arrangement. For most states, the net metering rules require the Distribution Company to buy the electricity.

In some arrangements, third party companies purchase and install the renewable energy source and sell that energy to the customer who occupies the site. There are states that have specific rules or laws prohibiting some types of arrangements between sellers and buyers in established utility territories, thus there are many types of arrangements that cannot be captured in this document.

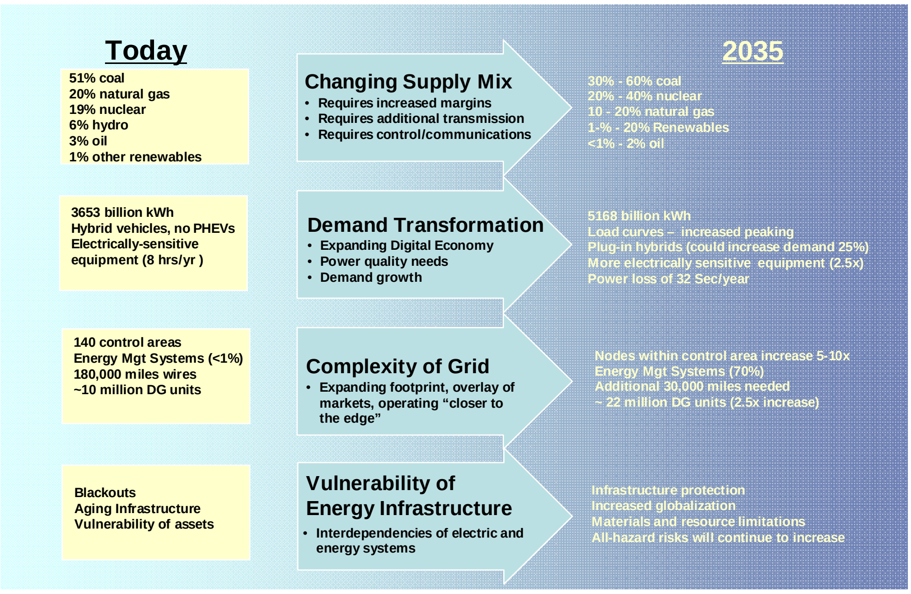


Eight states have renewable energy production incentives, which vary in duration and in amount per kWh. There are also at least six non-profit organizations that offer incentives for green tags or renewable credits to customers in eight states. And there are (at least) nineteen utility companies that offer production incentives for residential and commercial renewable energy sources.

Network (Grid) access of DER

Overall, the projection for future development of the U.S. electric power system (network-grid) based on current DOE Office of Electricity knowledge and including some DSM and DG up to the year 2035 is illustrated below[5]:

Preparing the Electric System Now to Meet Alternative Futures



According to other sources, such as the Energy Information Administration, renewables will change from 2.2% to 4.3% (2004 to 2030), nuclear will change from 20% to 15%, natural gas will change from 18% to 17%, coal will change from 50% to 57%, and hydro will change from 7% to 5% [6].

<u>Actors</u>

- Industry (DG manufacturing, integration)
- Utilities
- DG system owners
- State and federal government (policy)
- Local government (siting/permitting)
- IEEE, UL, NEC standards and codes organizations
- Government research (NREL/IEEE)

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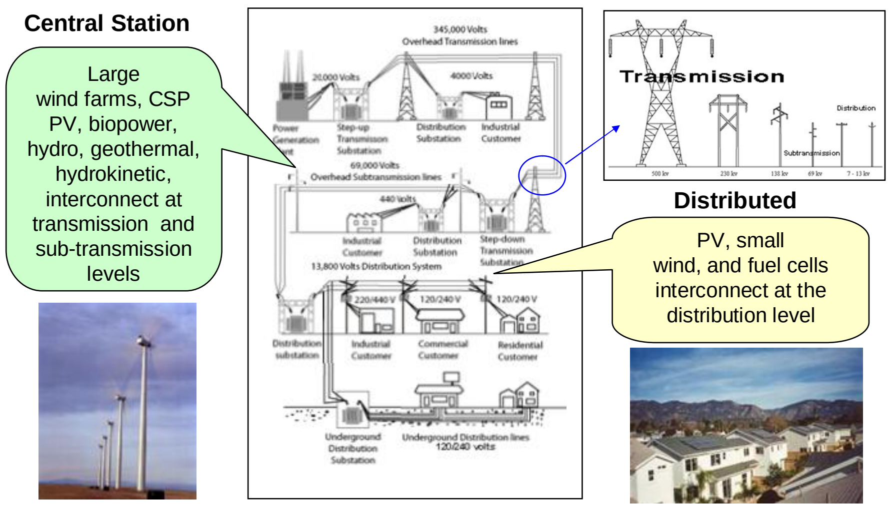
[5] DOE OE R&D Division Strategic Plan, September 2007
[6] Per EIA 2006 report http://www.eia.doe.gov/oiaf/aeo/index.html

- Governmental policy (EPACT 2005)

Grid Perspective

The U.S. electrical power system or Network (grid) – is illustrated below with central, distributed, and T&D integrated to provide the resources needed to meet load. DSM with regard to load management at the levels shown below provides the opportunity integrate distributed generation and resources at the right location for maximum optimization of power flow control and utilization.

Grid Perspective



<u>Status and key issues</u>

- National Policy directing states (EPACT 2005)
- Lack of consistent rules, policies, standards
- Extensive R&D underway
- Labor force adequacy -- planners, installers, engineers
- Utility education, modeling inadequate

<u>Projects</u>

- NREL develops IEEE 1547 and IEEE 1547.1
- UL 1741 developed for grid-tied systems
- P IEEE 1547.2 (application guide for IEEE 1547)
- IEEE 1547.3 (monitoring, information & control of DR)

- P IEEE 1547.4 (Guide design/operation/integration of Island systems)
- P IEEE 1547.5 (Guidelines for systems >10MW)
- P IEEE 1547.6 (Interconnecting with secondary networks)
- NREL/IREC workshops with state utility commissions to develop interconnection rules

Power quality issues

Actors
- Industry
- Utilities
- DG producers
- State Utility Commissions
- Government research
- Consumers

Status and key issues
- Reliability concerns for utilities and customers
- Integration with utility protective equipment
- Lack of consistent rules, policies, standards
- Extensive R&D underway
- Grid-tied equipment must not disrupt utility, must endure utility power

Market access of DER

Actors
- Utilities
- DG producers
- State and federal government (policy)
- Governmental policy, especially RPS
- Consumers

Status and key issues
- Net Metering rules vary
- T&D upgrades for market access
- Smart infrastructure requirements
- Dispatching DER
- Communications Standards
- Resource planning by utilities

Projects
- California CEC
- Public Interest Energy Research Programs in California

Description of the following themes (see the slides of Alison Silverstein in Madrid meeting):

Large renewables integration

Wind Systems Interconnection

Challenges:

- Transmission Interconnection & Congestion
- Lack of knowledge of operational impacts and integration costs of wind energy
- Shortage of power system professionals with knowledge of wind energy
- Policy treatment of wind energy as an electricity resource

DOE Action:

- Assess wind's potential to serve our Nation's electricity needs
- Develop tools to assist the electric utility industry analyze wind energy
- Perform operational and interconnection studies with industry stakeholders nationwide
- Provide education curriculum for the next generation of wind energy professionals
- Reach out to federal, state, and local stakeholders on the challenges and solutions to wind energy integration

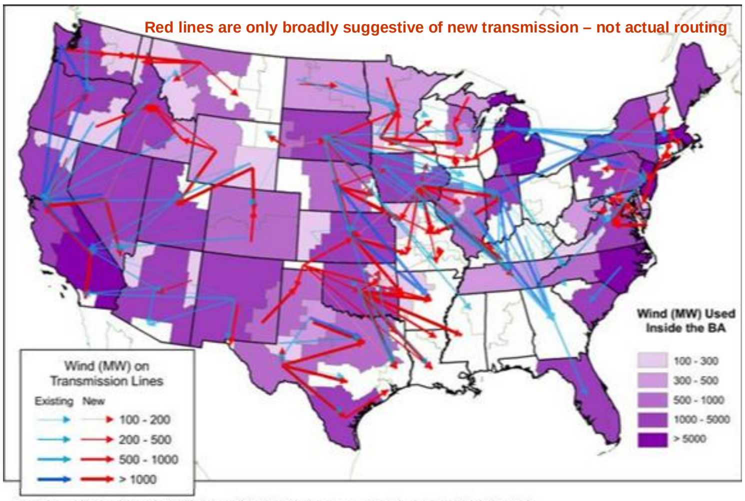
Results:

- Set the path for wind industry to accelerate its penetration
- Increase body of knowledge on wind/grid interconnection
- Help grow the delivery of emission-free energy from roughly 1 percent to the AEI's vision of 20 percent of our Nation's electricity usage

Actors

- Industry
- Utilities
- Wind producers
- State and federal government (policy)
- Local government (siting)

New central electrical generation, including wind energy, will require expansion of U.S. transmission



Total Between Balancing Areas Transfer >= 100 MW (all power classes, land-based and offshore) in 2030.
Wind power can be used locally within a Balancing Area (BA), represented by purple shading, or transferred out of the area on new or existing transmission lines, represented by red or blue arrows. Arrows originate and terminate at the centroid of the BA for visualization purposes; they do not represent physical locations of transmission lines.

<u>Status and key issues</u>

- Wind penetration nearing 10% in some areas
- Growing wind turbine and project size changes integration issues
- Reduce technology costs relative to other generation technologies
- Extensive R&D underway
- Wind production forecasting improving greatly, reducing integration costs
- EHV transmission planning, interconnection and construction
- Role of energy market, balancing energy services and products
- Labor force adequacy -- planners, installers, engineers
- Managing environmental animals, habitat, impacts from wind development

<u>Projects</u>

- 20% Wind by 2030 Vision Study
- Southwest Wind and Solar Integration Study
- Eastern Interconnect Wind Integration Study
- BPA's non-Wires transmission evaluation process
- Valuation of, compensation for wind capacity
- System voltage impacts, low-voltage ride-through rules
- Integration -- implementation and cost
- Use of power electronics for grid integration

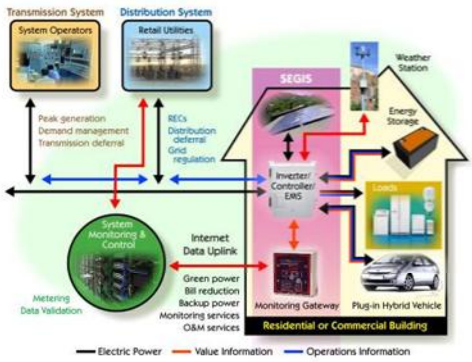
Small renewables integration

Integration of Renewables

- Technology research & development – both prime movers and their integration technologies
- Helping utility planners & operators learn from their peers and national experts what changes they need to make as renewables are added
- Implementing three Energy Policy Act of 2005 mandates that can reduce transmission uncertainty
- Providing best practice assistance to States that wish to change their electricity policies
- Encouraging regional coordination & thinking among States on State Electricity Policies

PV System Technology Development

- Need to develop *Solar Energy Grid Integration Systems (SEGIS)* -- inverter/controllers, energy management.
- Develop more reliable inverter and controller hardware.
- Embed voltage regulation in inverters, controllers, voltage conditioners.
- Investigate new DC power distribution architectures.

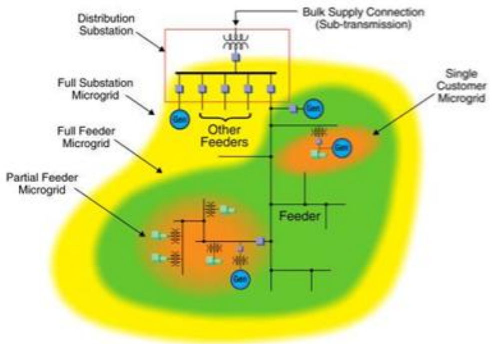


The Solar Energy Grid Integration System (SEGIS) Integrated with Advanced Distribution Systems

Actors
- Vendors
- Government research
- Governmental policy, especially RPS
- Consumers
- Utilities
- State regulators

Advanced PV Distribution Systems

- Increased distribution automation.
- Develop business cases that create opportunities on both sides of the meter and enables a *"market-driven response".*
- PV-friendly distribution systems.
- Multi-scale microgrid technologies.



Microgrid Examples on the Distribution System

Status and key issues
- Interconnection policies
- Physical/technical interface
- Installation
- Work force availability
- Compensation for feed of customer generation onto grid
- PV, others -- high cost of acquisition and acquisition is prohibitive
- Need to lower costs of small-scale renewables relative to retail end-use electricity prices

PV Renewable System Interconnection (RSI) Study

- **The RSI PV study was carried out during 2007 and consists of 14 reports plus an Executive Summary available at:**
  - http://www1.eere.energy.gov/solar/solar_america/rsi.html
- **RSI PV Reports**
  - Advanced Grid Planning and Operations
  - Utility Models, Analysis and Simulation Tools
  - Advanced PV System Designs and Technology Requirements
  - Development of Analysis Methodology for Evaluating the Impact of High Penetration PV
  - Distribution System Performance Analysis for High Penetration PV
  - Enhanced Reliability of PV Systems with Energy Storage and Controls
  - Transmission System Performance Analysis for High Penetration PV
  - Renewable System Interconnection Security Analysis
  - Solar Resource Assessment: Characterization and Forecasting to Support High PV Penetration
  - Test and Demonstration Program Definition to Support High PV Penetration
  - Value Analysis
  - PV Business Models
  - Production Cost Modeling for High Levels of PV Penetration
  - PV Market Penetration Scenarios

Projects
- Valuation of emissions offsets, compensation
- Compensation for value of generation behind the meter
- Community wind developments
- Utility concern over backfeed onto grid

Nonrenewable distributed generation and storage

Actors
- Consumers
- Vendors
- Utilities
- Government policy
- Local building and efficiency standards

Key issues
- Cost of devices -- need to increase efficiency, reduce emissions, reduce costs
- Diesel/combustion -- safety (especially CO inhalation and backfeed concerns)
- Ease of installation and use
- Air quality and GHG emissions
- Plug-in hybrid electric vehicles
- Battery technologies and cost
- CHP widespread for industrial uses

- Need common interface, communication and control schemes
- Business models -- individual or fleet; utility or consumer control?

Projects
- Department of Energy
- California Energy Commission
- NYSERDA
- Con Edison
- Distributed Utility Association

Energy efficiency and DSM

Integration of Demand Side Mgt with the Grid: Energy Efficiency & Renewables/Storage/DG

- There is a strong expanded and new nationwide interest in utility-delivered energy efficiency because it provides: a cheap source of electricity; encourages private utilities making proposals to their State commissions for more and State commissions opening regulatory dockets; stimulates national Action Plans for Energy Efficiency (voluntary effort of industry/States); help in establishing state efficiency portfolio standards & carbon cap and trade programs; enables technologies ("smart grid") ties; and generates interest in RTO and non-RTO regions. Only ISO-NE currently uses efficiency (in its "forward capacity market") for Wholesale. Alas one form of efficiency integration can be used to reduce the need for renewable generation/DG at both bulk power and end-use level.
- Better treatment of efficiency in integrated resource plans (IRPs) by those who do IRP and to the degree that integrated planning occurs, it primarily takes demand response/efficiency as exogenous variables and plans T and G around them - which is to say, no integrated planning at all. BPA's Olympic Peninsula demand response and efficiency demo provides a transmission deferral with the exception of BPA's policy at looking at demand response/efficiency *before* building transmission
- There is a strong interest in the US in demand response – that is evolving and growing. Currently 5% of US peak load has demand response capability with most wholesale use of demand response done by RTOs/ISOs, (ie ERCOT, PJM, ISO-NE, CALISO, NYISO) and is relatively new & evolving. Emergency programs are used by grid dispatcher part of RTO to maintain reliability with ERCOT (Texas) using its reliability DR programs on Feb 26 to avoid blackout from sudden drop in wind generation; CAISO experiment with 700 buildings controlled to balance wind (Site Controls Inc.); and there is growing interest by the wind industry to use demand response.
- Most retail use of demand response is done as traditional load management (controls on water heaters & air conditioners) in vertically integrated utilities (outside of RTOs) and also by rural coops/public power utilities to manage peak pricing by their wholesale supplier. There is renewed interest in encouraging retail demand response bundled into wholesale markets and Interest in more widespread use of demand response due to new enabling technologies and for new applications. Some use of dynamic pricing as form of demand response is encouraging as well as early emerging interest to use demand response to balance wind & solar
- There is not much use, yet, of DR to complement intermittent renewables.

Actors
- Vendors
- DOE
- State regulators
- T&D utilities
- End use customers
- State and federal regulators
- Consultants and advocates
- Energy service companies

Status and key issues
- EE very cost-effective relative to supply resources
- National Action Plan for Energy Efficiency

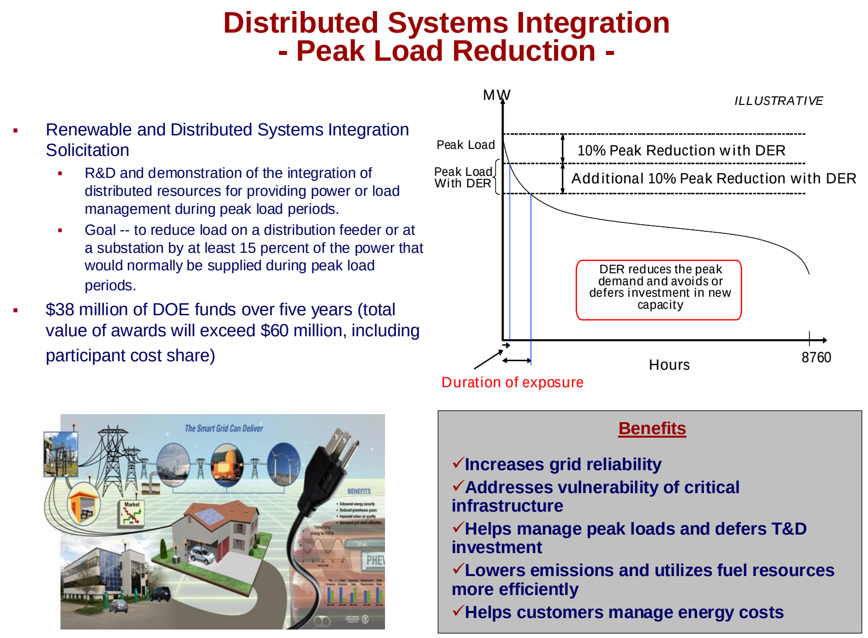
- Growing penetration of EE; slower growth of DR
- How to develop EE and DR into full equivalents of supply resources
- Advanced metering spreading slowly
- “The building as a battery”
- Developing data and technology to characterize changing load profiles
- Advanced metering and meter data management
- Efficiency standards for buildings, devices

Projects

- Building automation
- Vendors -- Site Controls, Enernoc, GridPoint, City of Austin zero-net energy house
- CA, NY, NJ lead states
- PPL, SCE, City of Austin, DTE
- Lawrence Berkeley, NREL, Environmental Protection Agency, Department of Energy, FERC

Smart grid

Many applications of smart grid technology is being conceptualized and looked at as solutions to power flow control and reliability. The following peak load reduction application illustration provides an example of such applications:



Developing advanced grid technologies needed for operational integration of DSM, DG, and renewables include:

- Communications
- SCADA, T&D automation and monitoring

- Advanced metering and meter information analysis
- Coordination and controls
- Modeling and analytics for current condition analysis, forecasting, and simulation of individual elements and interactions on the grid
- Interoperability protocols and standards

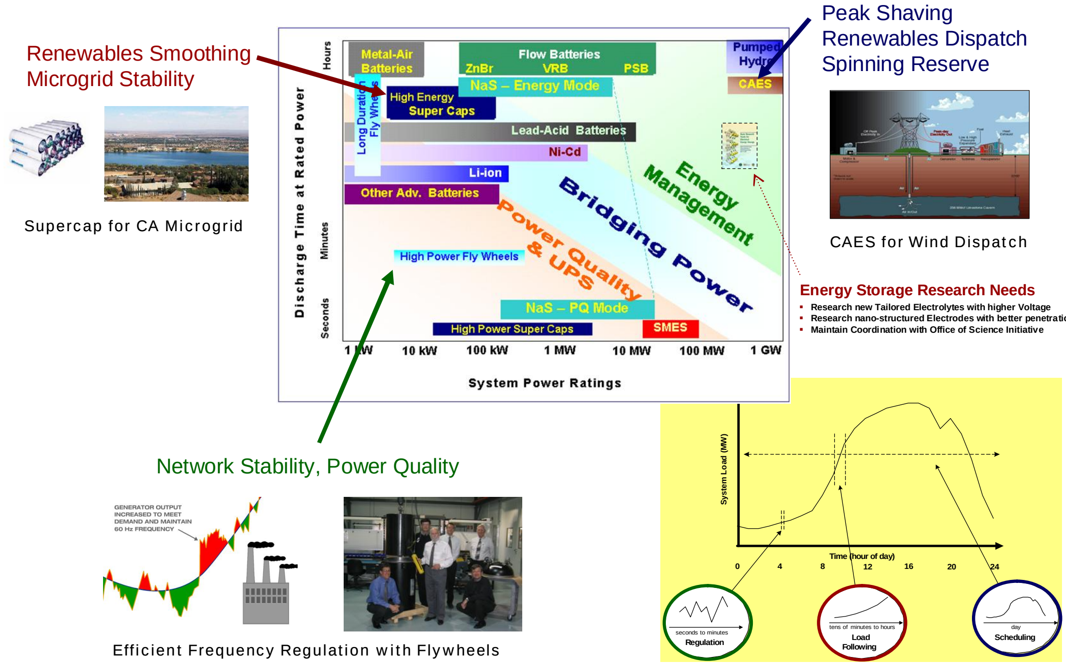
Actors
- Vendors, industry
- Dept of Energy
- State regulators
- Utility asset purchasers

Key issues
- Isolated applications
- Multiple smart grid advocates and analysts
- Interoperability and standards are critical for successful applications to integrate and cooperate
- Utility industry reluctance to adopt standards, protocols from other industries
- Breadth of players -- from user devices up to power plant -- creates huge scope and challenge
- Too much proprietary technology, slow move toward open architectures

Projects
- Many by vendors, consultants
- Lots of agent-based work
- Individual demos on very small scale, e.g. SCE Feeder of the Future
- Drivers are advanced metering, system reliability
- Smart devices v. smart systems
- Multiple smart grid advocates

Integration of DSM with DG/RES/storage

Integration of Energy Storage Technologies and Applications



<u>Actors</u>

- Vendors
- Research organizations
- Utilities

<u>Key issues</u>

- Development of architecture, tools for control, communications, cooperation from device up through distribution and transmission to power plant
- Market structures complicate integration -- how to cover costs of new technologies
- Consumer interests don't support "grid optimization"
- Utilities want control, consumers want freedom
- Compensation for integration capabilities and value
- Design system for net variability, not element-specific intermittency
- Design interoperability around functions, not technologies -- physical, semantic and communications, business rules

<u>Projects</u>

- Hawaii sustainable energy transformation (shown below)
- City of Austin sustainable city

- California
- Western Wind and Solar Integration study (shown below)

Hawaii MOU: Strategic Projects will help overcome technical barriers and driving State policy change

- **Projects already in process:**
  1. ***Lanai High-Penetration Renewable Energy Grid***
     - Early small-scale renewable transformation showcase
  2. ***Optimizing EE and RE Use for Military Housing Communities***
     - Targeting zero energy, demand-responsive model
  3. ***Grid Stability Solutions for Variable Renewables***
     - Enabling utilities to implement cost-effective software/hardware solutions for increased wind, solar, ocean energy
  4. ***Bioenergy Feedstock Identification and Industry Development***
     - Defining in-State biofuels production strategy
- **Status:**
  - Partner meetings following MOU signing
  - Funds allocated, laboratory/industry teams forming
  - Project planning control documentation drafted
  - Finalize plans with utility, industry, and State partners Mar/April
  - Initial implementation steps underway

Figure 10. Geothermal Resources on the Island of Hawaii


Hawi Renewable Development LLC Wind Farm at Upolu Point near Hawi on the Island of Hawaii. Source: Hawaiian Electric Light Company via NREL Photo Information Exchange.

More projects will be identified through the working groups

Western Wind and Solar Integration Study