U.S. Policies to Reduce the Impact of Energy Use on the Environment – Trends and Implications

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PRESENTED BY

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THE Brattle GROUP

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Impact of Disruptive Technologies

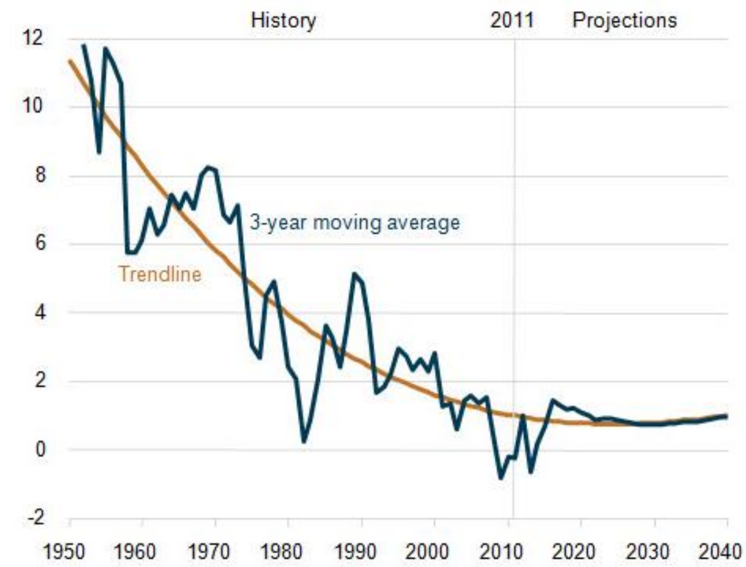
In the U.S., electricity usage has fundamentally changed as most regions expect only ~1% growth due to:

- Energy efficiency (utility programs, lighting and A/C standards, customer preference)
- Demand response (AMI/smart meters, dynamic pricing)
- Distributed generation (solar, backup generators)
- Storage and EVs (further into the future)

The implications of disruptive technologies include:

- Reduction in electricity usage growth
- Persistent overcapacity, especially as Renewables and demand response enter ahead of need
- Tension over rate recovery on infrastructure and rate design

U.S. Electricity Demand Growth Rate

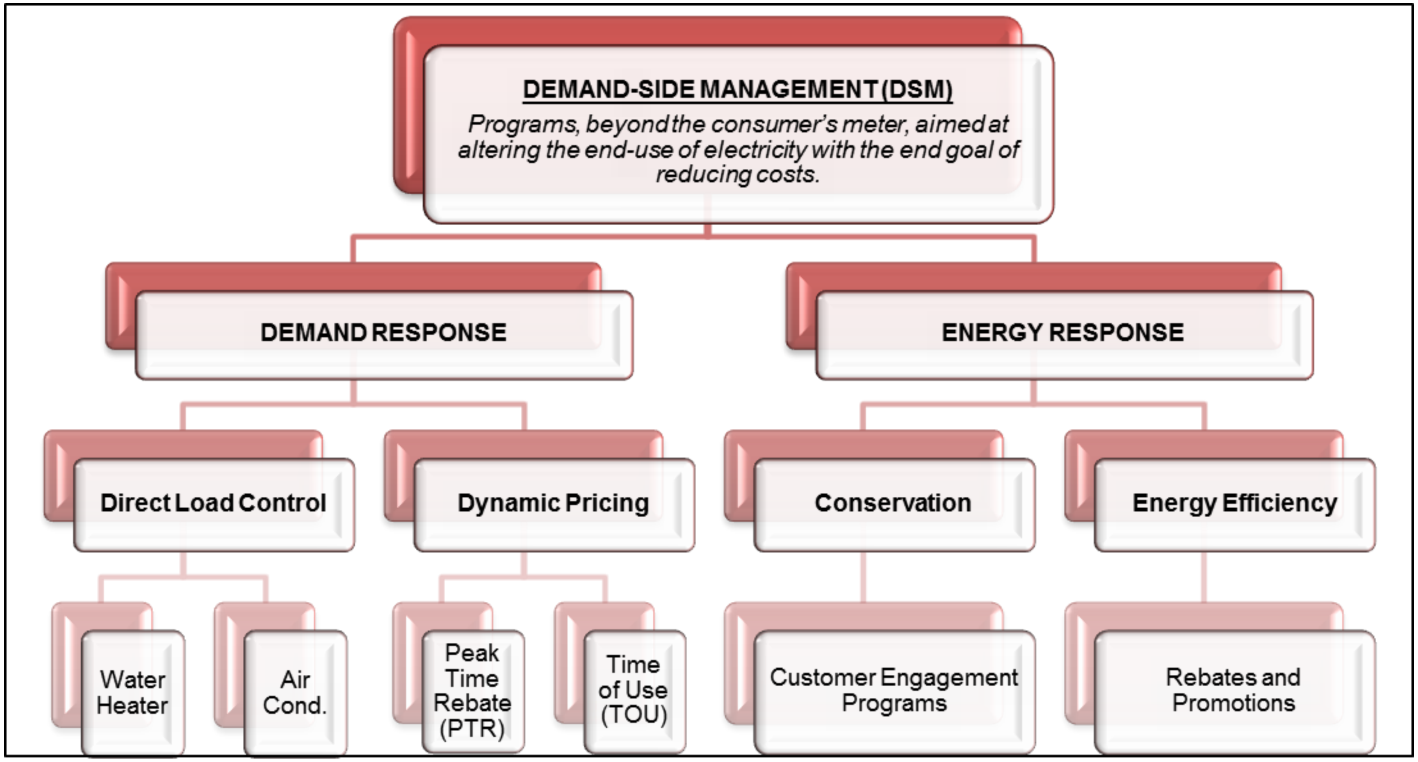


Source: EIA, 2013 Annual Energy Outlook (note that this projection of total energy demand does not include future growth of EE, DR, and DG)

Brattle survey of two dozen utility load forecasters suggests 0.7% to 0.9% future annual growth

Demand Side Management (DSM) Programs

DSM programs aim to alter the end-use of electricity to reduce costs and include both Demand Response (DR) and Energy Efficiency (EE)



Source: Power System Engineering, Inc, *SF DSM Results*, Feb 15, 2013 presentation

Trends in Energy Efficiency

Energy efficiency (EE) programs have been around for decades with increased focus recently due to new federal codes/standards and state-mandated utility EE programs, such as:

- Efficient light bulbs and appliances
- Retrofits of commercial buildings
- Higher efficiency materials in new construction

States require that utility EE programs undergo an evaluation of the cost effectiveness of investments for commission approval

The tests calculate cost effectiveness by considering the following benefits of EE:

- *Energy savings*: Reduced energy usage results in lower electricity bills
- *Capacity savings*: Energy efficiency programs implemented by Sunflower can reduce the need for future investment in additional capacity
- *Transmission and Distribution savings*: EE can delay the need to upgrade T&D systems that are approaching their capacity limits (generally smaller than other two benefits)

Examples of Efficiency Gains

Higher efficiency products required by codes and standards set by the Department of Energy will slowly begin to effect load due to the gradual turnover of most common household appliances:

Appliance	Efficiency Gain
Lighting (CFL vs Incandescent)	~75%
Air Conditioners	Up to 50%
Water Heaters	10 – 50%

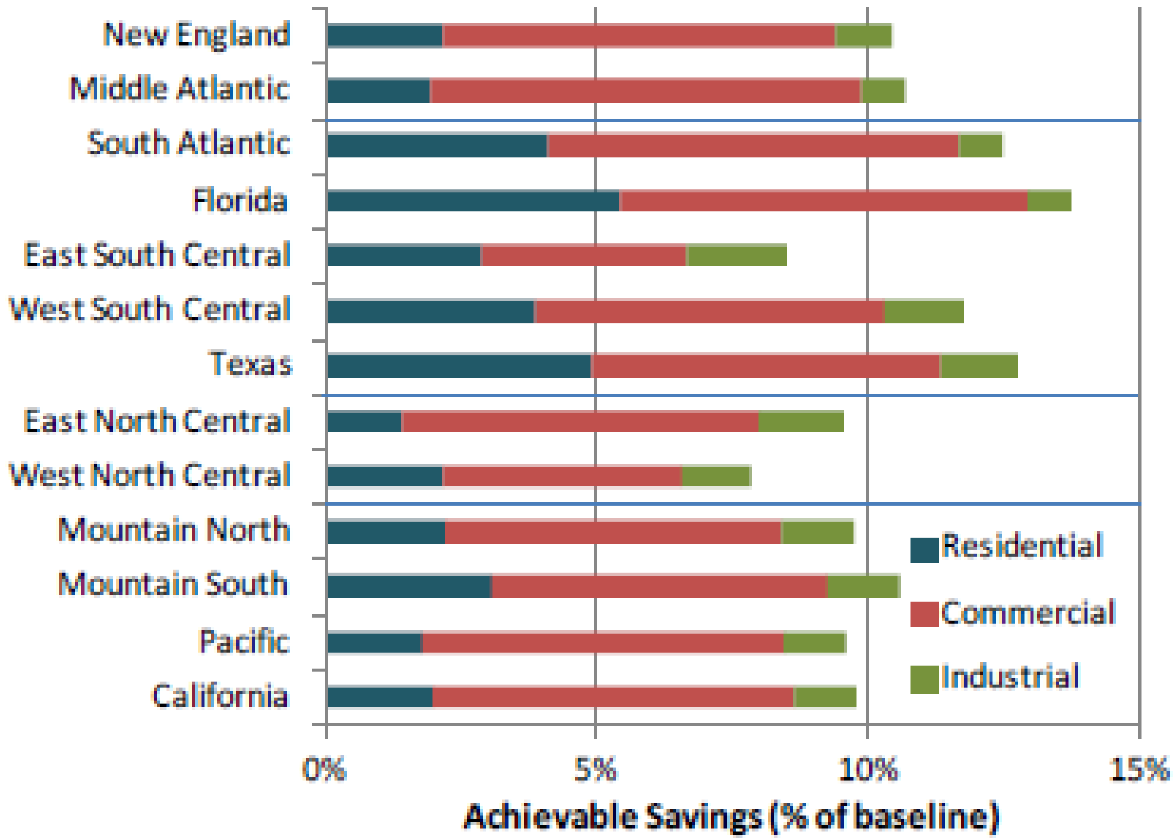
Source: U.S. Department of Energy

Over ten years, adoption of high efficiency appliances will significant reduce load growth below current trends.

Energy Efficiency Policies in the U.S.

- From U.S. experience, regional and state target savings compared to baseline range from 8 - 14% by 2035.
- Annual load reduction from EE range from 0.4% (modest) to 1.5% (aggressive).

2035 Potential as a % Baseline Consumption



Sources: "US Energy Efficiency Potential through 2035", p.175, EPRI 2014 Technical Report

Trends in Demand Response

Demand response (DR) refers to any attempt to reduce load during capacity scarcity or high price hours.

- DR can reduce rates and customer costs by avoiding generation investments.
- DR can help balance renewable generation and provide ancillary services.
- DR may also be used to "store" energy and shift load patterns.

Types of DR:

- Interruptible load/tariffs: mostly industrial
- Direct load control (DLC): utility controls load to appliances, such as A/C, irrigation, and water heaters
- Dynamic pricing: time of use (TOU) rates, *peak time rebates (PTR), critical peak pricing (CPP)*
- Dynamic pricing plus *Enabling Technologies:* programmable communicating thermostat

The more advanced forms of time varying prices (shown in *italics*) require deployment of "smart meters."

Trends in Distributed Generation (DG)

DG costs are falling fast:

- PV, wind, and onsite gas generators (turbines, fuel cell) costs are falling rapidly
- Although there are several DG technologies, the real story is Solar PV
- Most utilities may not be quick enough to adapt to this new reality

DG emerges as an important tool in reliability and resiliency management

- Due to reliability and resiliency benefits, investment in DG may make sense even if it does not have lower levelized costs

DG can address local congestion and flow problems

- Delay or avoid upgrading transmission and distribution investments, substations; avoids investment in transmission capacity that might go unutilized for years
- Especially relevant when the capacity shortfall is expected only for a few hours in a given year

But DG can also increase investments in infrastructure

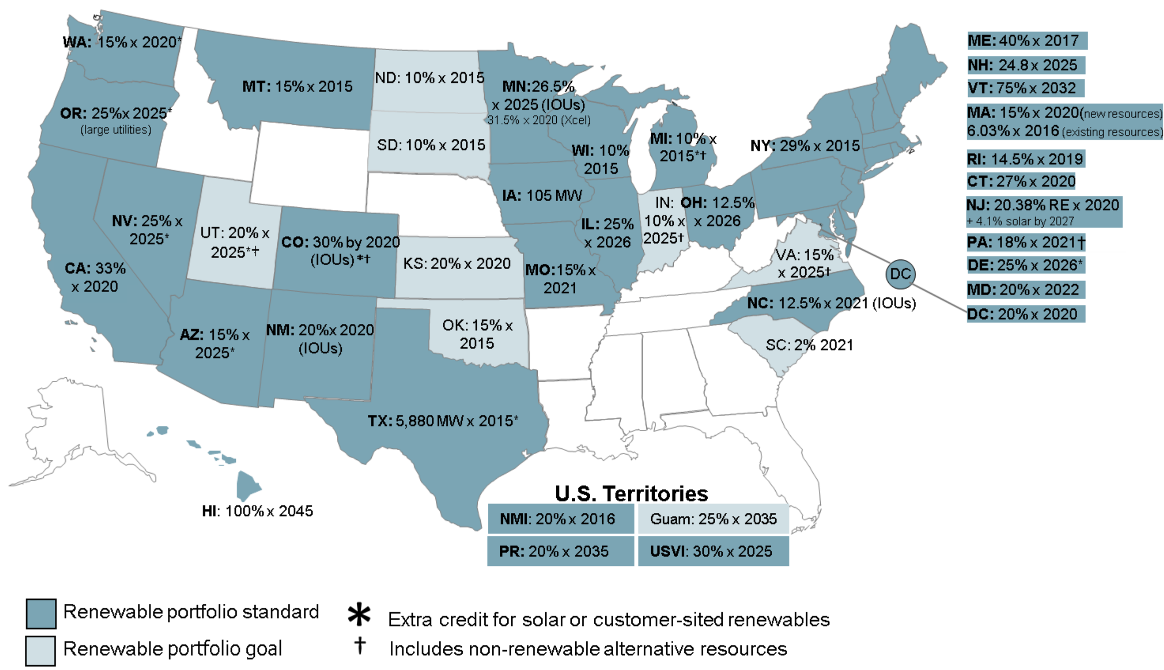
- Local distribution systems must be strengthened to support DG

U.S. Regulatory Policies on Renewable Energy

- Federal Production Tax Credit of ~$23/MWh.
- Renewable Portfolio Standards set the quantity of energy that must be met by renewable energy.
- Prominent examples in U.S. markets:
  - 29 U.S. states have RPS and 8 more have voluntary goals (in the range of 15% - 20% of retail load).
  - California has the most aggressive policies, which has driven renewable investments across the west.

Renewable Portfolio Standards in the U.S.

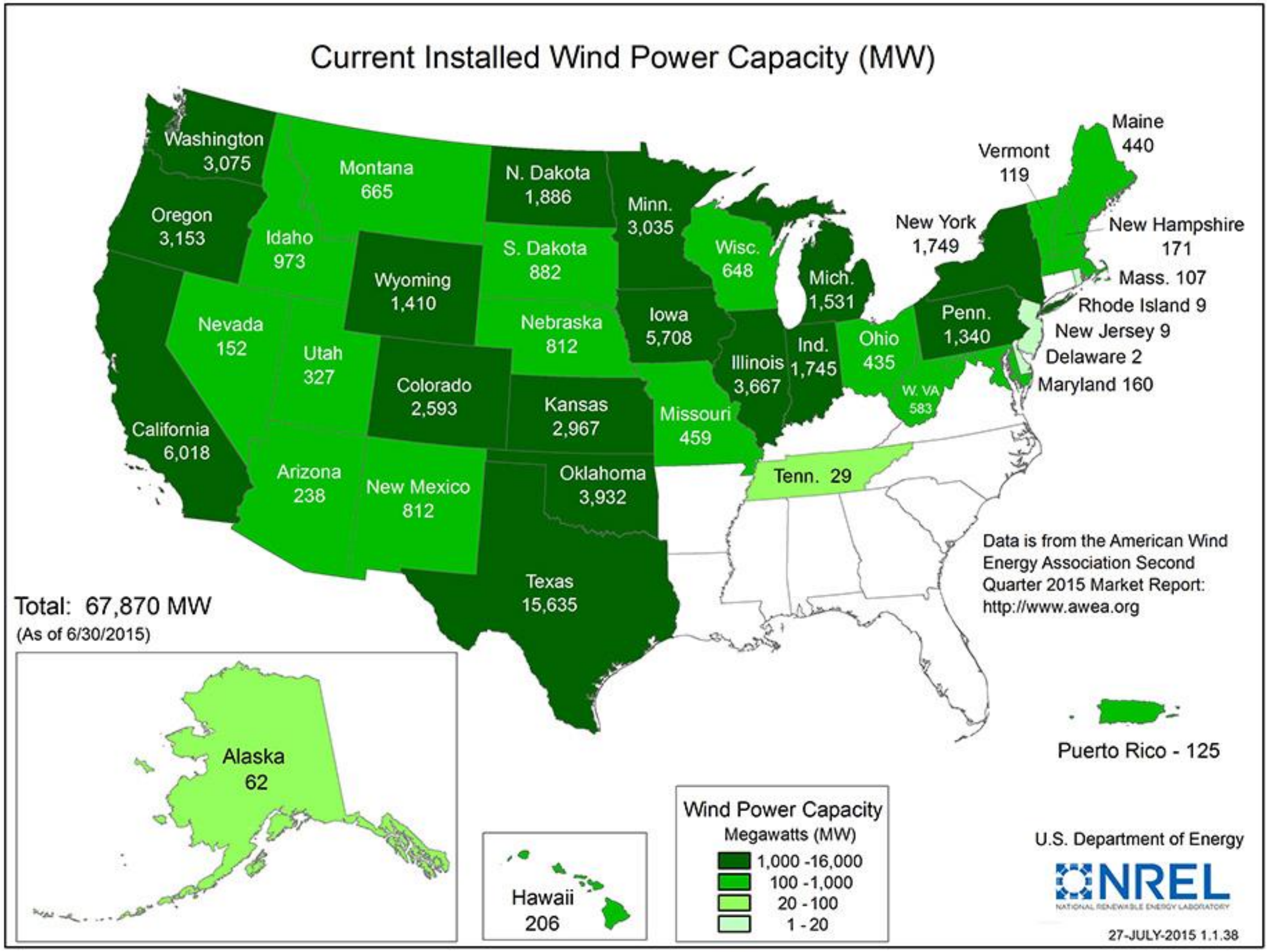
July, 2015



Source: Database of State Incentives for Renewables and Efficiency

Resulting Renewable Generation in the U.S.

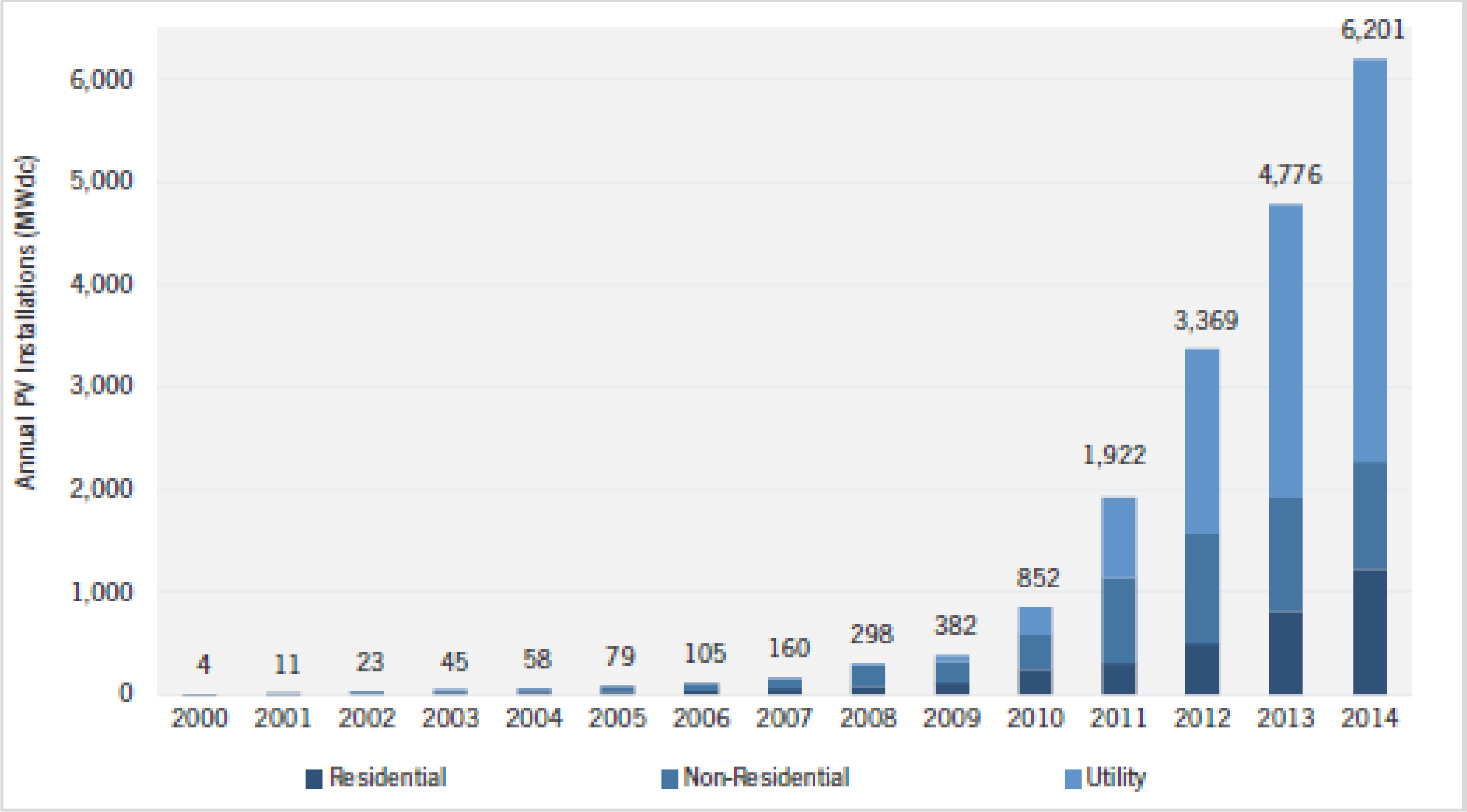
- Wind is plentiful in the Great Plains of the U.S.
- Thus, some amount of wind generation output are purchased based on economics



Solar Capacity Growth

U.S. solar PV generation increased to 18,300 MW at the end of 2014.

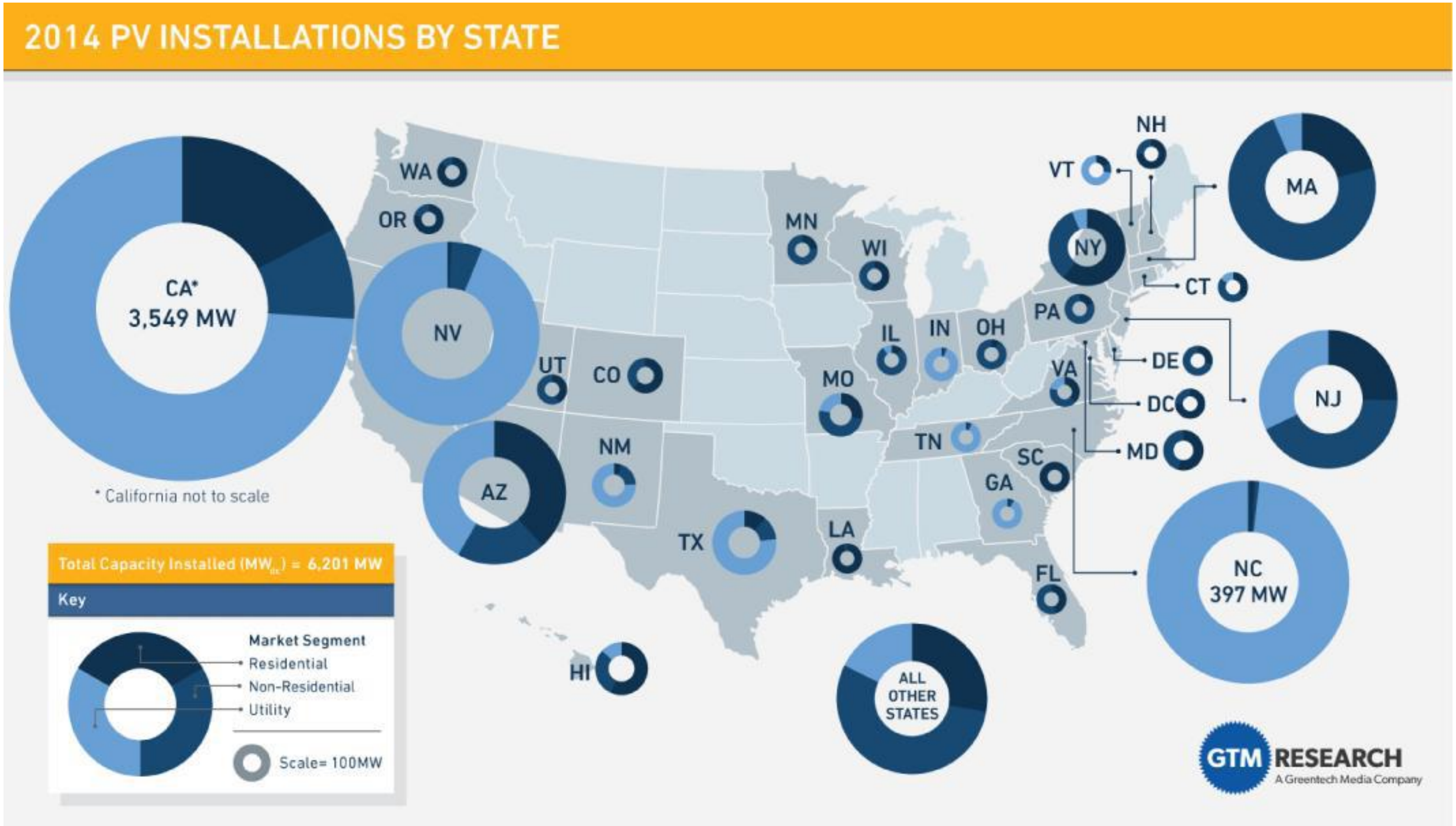
- Initial growth primarily in residential and commercial installations
- Utility-scale projects now accounts for over 50% of new capacity



Source: SEIA at http://www.seia.org/sites/default/files/HOlFT6ym3i.pdf

Latest Growth in Solar PV

- Fastest growing states are those with the greatest policy incentives



Cost Trends for Solar PV

Installed cost has decreased significantly over past decade – about 10%/yr (pre-ITC costs)

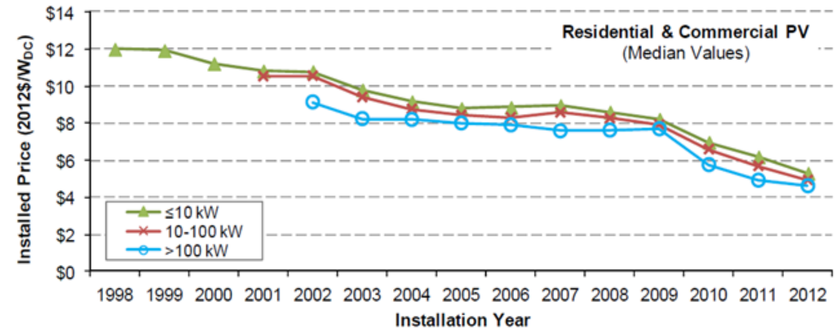
- Res. & comm. PV (<100 kW) at **~$5/Watt**
- Large utility-scale PV (>10 MW) at **~$3/Watt**

Neighboring states (CO/TX) have some of the lowest installed costs, ~20% lower than U.S. average

Installed costs are expected to decline further, but unclear how steeply and at what level it will start to slow down

- Module prices dropped ~**75%** in past 5 years
- U.S. installed cost is 2x Germany's; mostly **"soft costs"** (installation, permitting, site prep, etc.)
- Future installed cost savings must come from "soft costs"; there appears to be significant opportunity

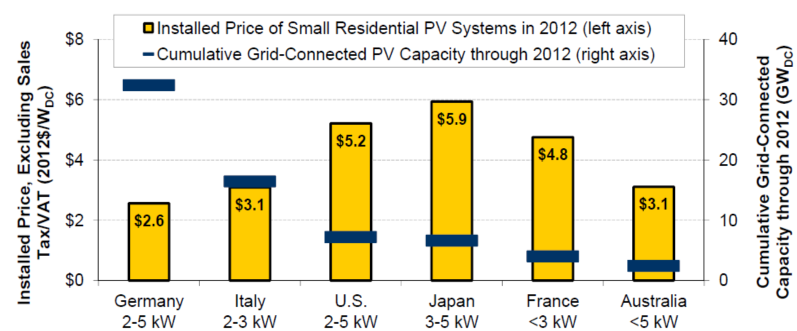
Installed Cost of Residential and Commercial Solar PV



State Specific Cost of Residential and Commercial Solar PV

System Size	TX	CO	Average
<10 kW	$3.9/W	$4.1/W	$5.3/W
10 - 100 kW	$4.5/W	$3.7/W	$4.9/W
>100 kW	---	$3.2/W	$4.5/W

International Solar PV Installed Cost Comparison



Sources: Tracking the Sun IV: The Installed Cost of PVs in the US from 1998 to 2012 (LBNL, July 2013)

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Defining the Potential of Disruptive Technologies

How Utilities View the Challenge

- Business Models
- Strategies

Utilities May Need a New Business Model

Disruptive technologies threaten traditional business models

Identify new business models and services that can help address lost margins (similar to phone companies)

- Expand into smart services (energy management), become an "Energy Service Utility"

Ownership of distributed resources at the customer site

- Could be difficult as the core strength of the utility does not lie here

Reform to rate design may be critical

- Shift to value pricing by increasing customer demand charges and reducing volumetric kWh rates

Initiatives to Prepare for Low Growth

1. **Rate Design:** Shift from rates that are primarily volumetric to those that are based on straight fixed and variable designs

2. **Load Forecasting**: Forecasting models have been over-forecasting sales without considering changing customer tastes and behavior; consider including insights from observational market research based on frequent and ongoing interactions with consumers

3. **Load and Market Research**: Integrate processes to yield insights not just about the past and current patterns of use but about likely future changes

Strategies for Dealing with Low Growth

1. **Stay the Course:** Assume growth will resume by itself; declining energy prices will herald an industrial revival and boost electricity sales

2. **Electrification:** Push on plug-in electric vehicles and other plug loads; will only payoff in the long run with very limited benefits in the near-term

3. **Safe Haven:** Become a wires company, but will still face the risk of collecting insufficient revenue since the bulk of distribution charges are tied to sales

4. **Go on the Offensive**: Creation of a new enterprise culture that will compete with mainstream solar companies

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Defining the Potential of New Energy Technologies

How Utilities View the Challenge

Massachusetts Clean Energy Center's Role

MASSACHUSETTS CLEAN ENERGY CENTER

The MassCEC Mission

Build sustainable industry to create jobs, long-term economic growth

Cultivate a robust marketplace for innovation in clean technologies

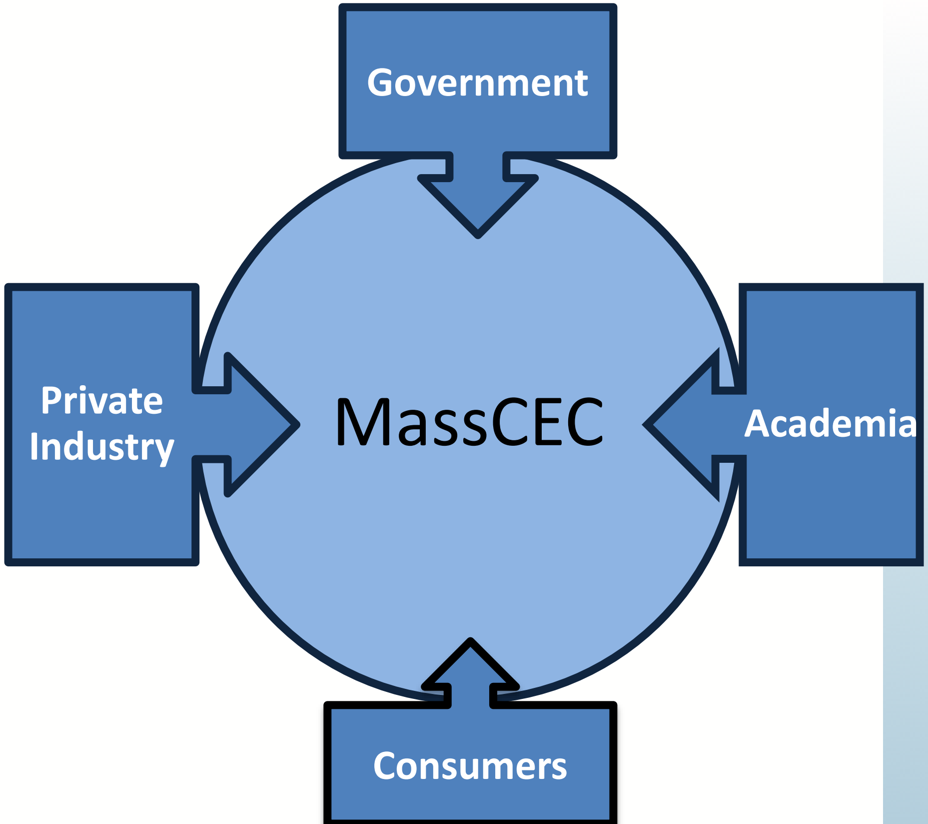
Accelerate cost reduction for clean energy technology

Support training and education to build a skilled workforce

Our Role: Industry Hub

MassCEC drives job growth, adoption, and innovation by:

- Fostering dialogue among government, industry, academia and consumers
- Facilitating partnerships within and between industry, energy consumers and government
- Implementing market-focused initiatives to accelerate economic growth and complement policy and regulation
- Developing strategic programs to reduce costs of clean energy adoption



MassCEC Structure

MASSACHUSETTS CLEAN ENERGY CENTER

Renewable Energy Generation

- **Support the deployment** of clean technologies across the Commonwealth
- **Drive down energy prices** state-wide
- Manage key **cleantech infrastructure**: WTTC, Marine Commerce Terminal

Investments

- Provide **funding (debt and equity)** to companies along the entrepreneurial lifecycle to accelerate the commercialization of new technologies and attract private capital to promising companies

Innovation and Industry Support

- **Support and accelerate innovation** in clean energy and water innovation technology
- Support the **development of a trained and diverse workforce** to meet the needs of the rapidly growing Cleantech industry
- **Analyze** the growth and development of the industry to ensure transparency and effective impact

Programs of Interest

- **Catalyst Program** – Grants up to $40,000
- **InnovateMass Program** – Grants up to $150,000
- **Investments in advancement of technology** – $500,000
- **Investments in job creation** – $100,000 to $1 million
- **IncubateMass Program** – Targeted financial support for clean energy incubators
- **Mass as First Customer** – Connecting innovative technologies public sector customers
- **Internship Program** – Funds for clean tech companies to take on paid student interns
- NEW: **Solar Loan Program**
- NEW: **Water Innovation Trust**
- NEW: **AccelerateMass**

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Note:

The views expressed in this presentation are strictly those of the presenter and do not necessarily state or reflect the views of *The Brattle Group, Inc*.

Ms. Judy Chang is an energy economist and policy expert with a background in electrical engineering and over 18 years of experience in advising energy companies and project developers with regulatory and financial issues. Ms. Chang has submitted expert testimonies to the U.S. Federal Energy Regulatory Commission, U.S. state and Canadian provincial regulatory authorities on topics related to transmission access and renewable energy. She also has authored numerous reports and articles detailing the economic issues associated with system planning, including comparing the costs and benefits of transmission. In addition, she assists clients in comprehensive organizational strategic planning, asset valuation, finance, and regulatory policies.

Ms. Chang has presented at a variety of industry conferences and has advised international and multilateral agencies on the valuation of renewable energy investments. She holds a Bachelor of Science in Electrical Engineering from University of California, Davis, and a Master's in Public Policy from Harvard Kennedy School, is a member of the Board of Directors of the Massachusetts Clean Energy Center, and the founding Executive Director of New England Women in Energy and the Environment.

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