The Brattle Group

The Future of Demand Growth

How five forces are creating a new normal

Ahmad Faruqui, Ph. D.

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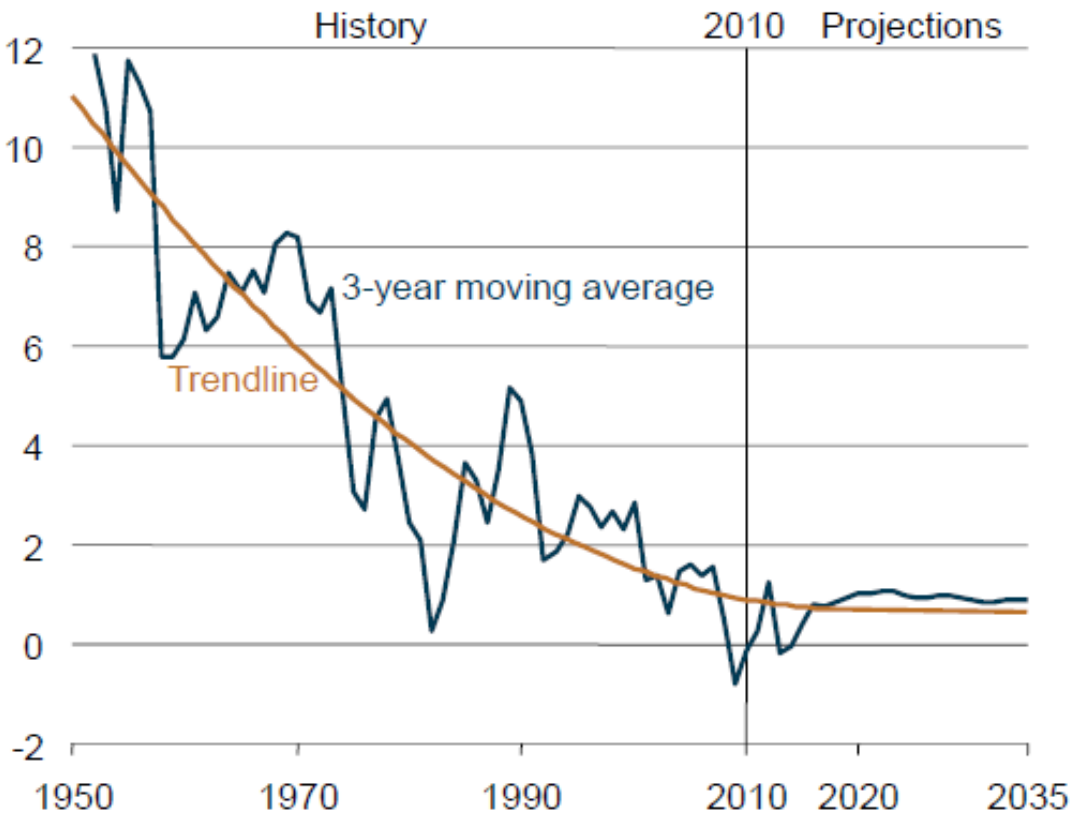
The long arc of history points toward declining growth

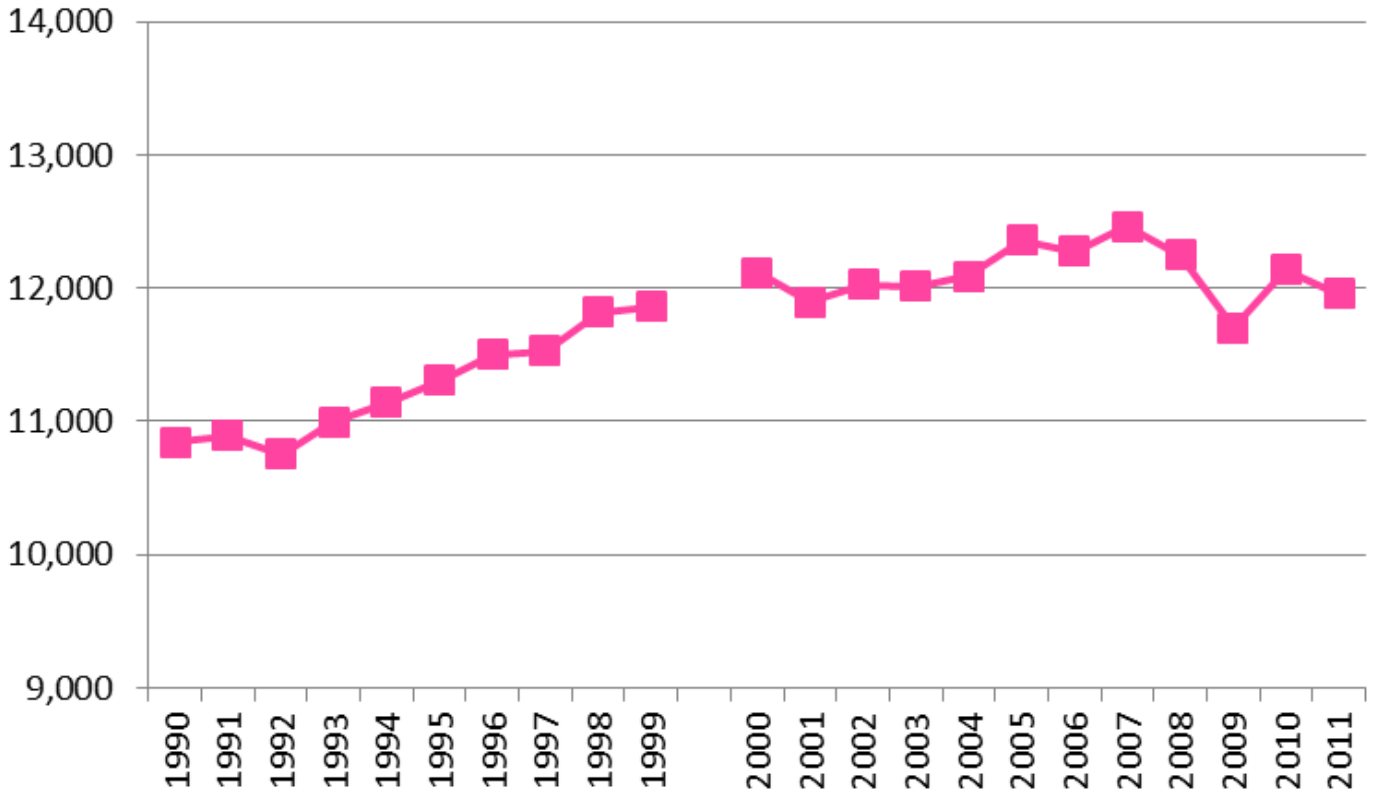
U.S. Electricity Demand Growth, 1950-2035 (percent, 3-year moving average)



Source: EIA, 2012 Annual Energy Outlook

After rising in the 1990s, per capita consumption has flattened off

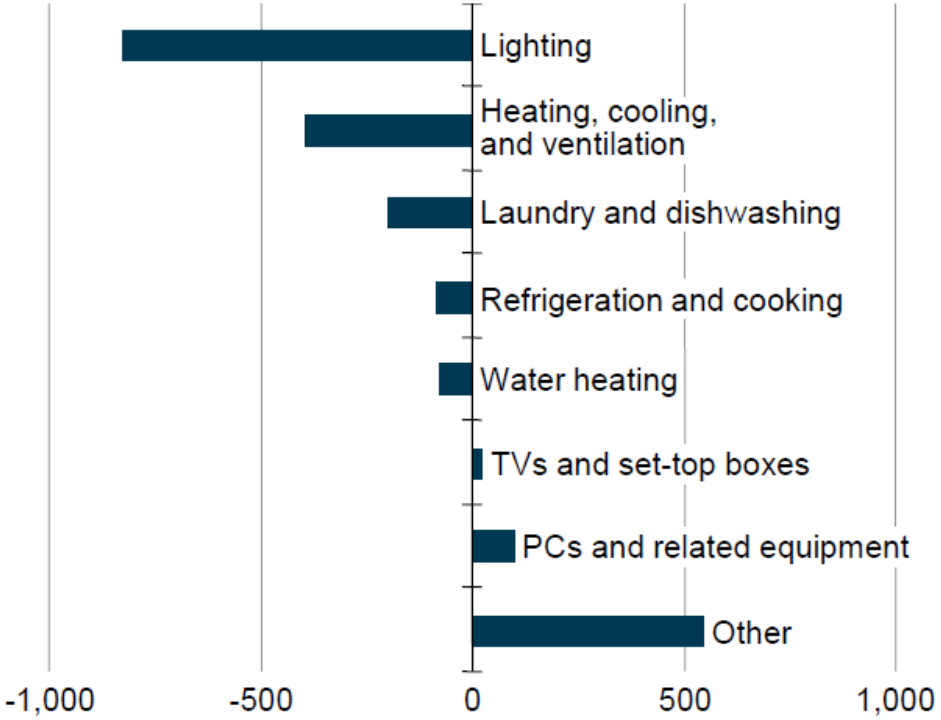
Per Capita Electricity Consumption, U.S. 1990-2011, in kWh



Source: eMeter, based on DOE and Census Bureau data

The EIA predicts declining residential electricity consumption per household through 2035

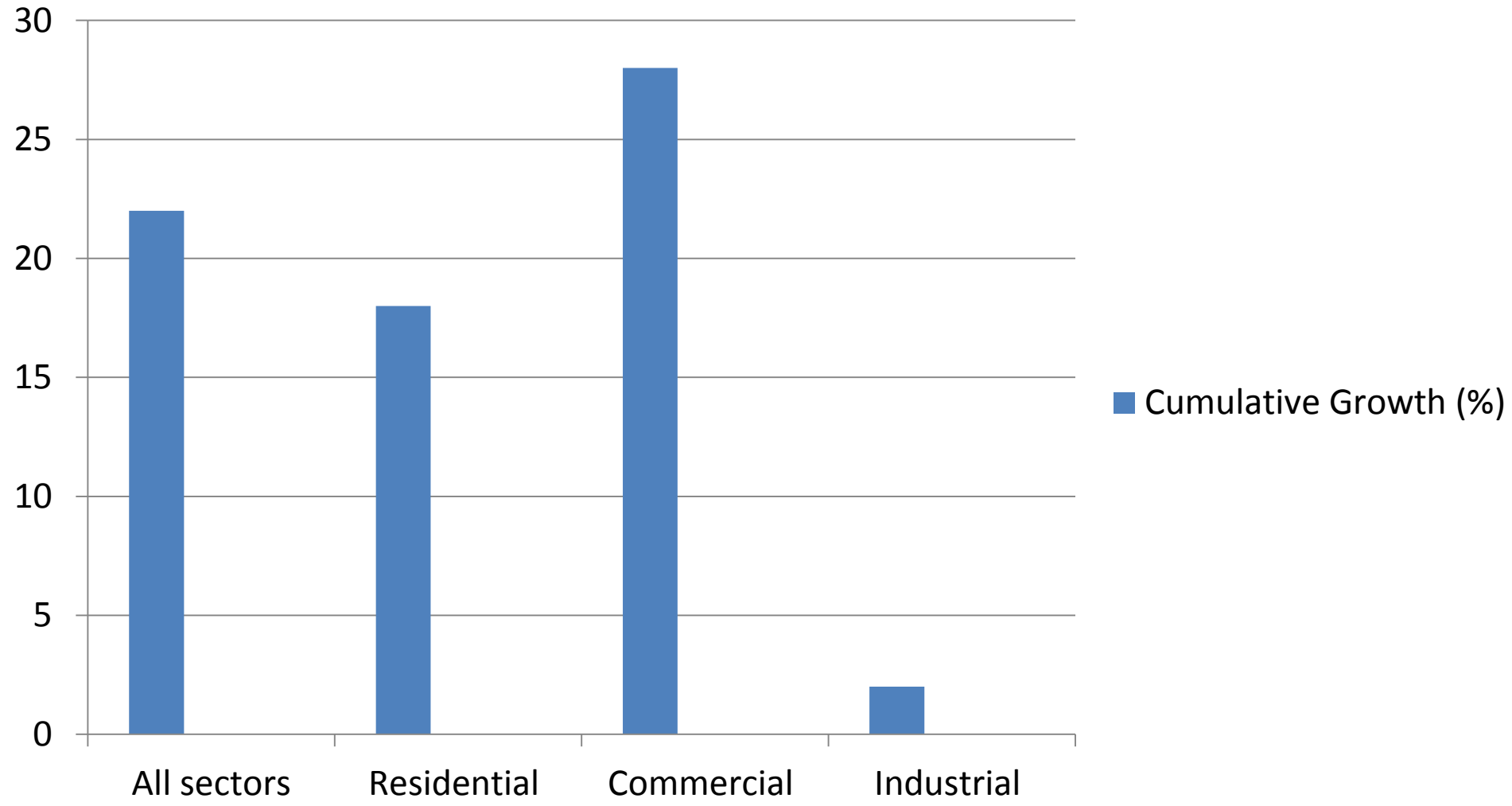
Change in Residential Electricity Consumption for Selected End Uses (Reference Case) kWh per household in 2035 compared to 2010



On an aggregate basis, total delivered electricity use in the residential sector grows at an average rate of 0.7% per year in the 2012 AEO reference case forecast

Source: EIA, 2012 Annual Energy Outlook

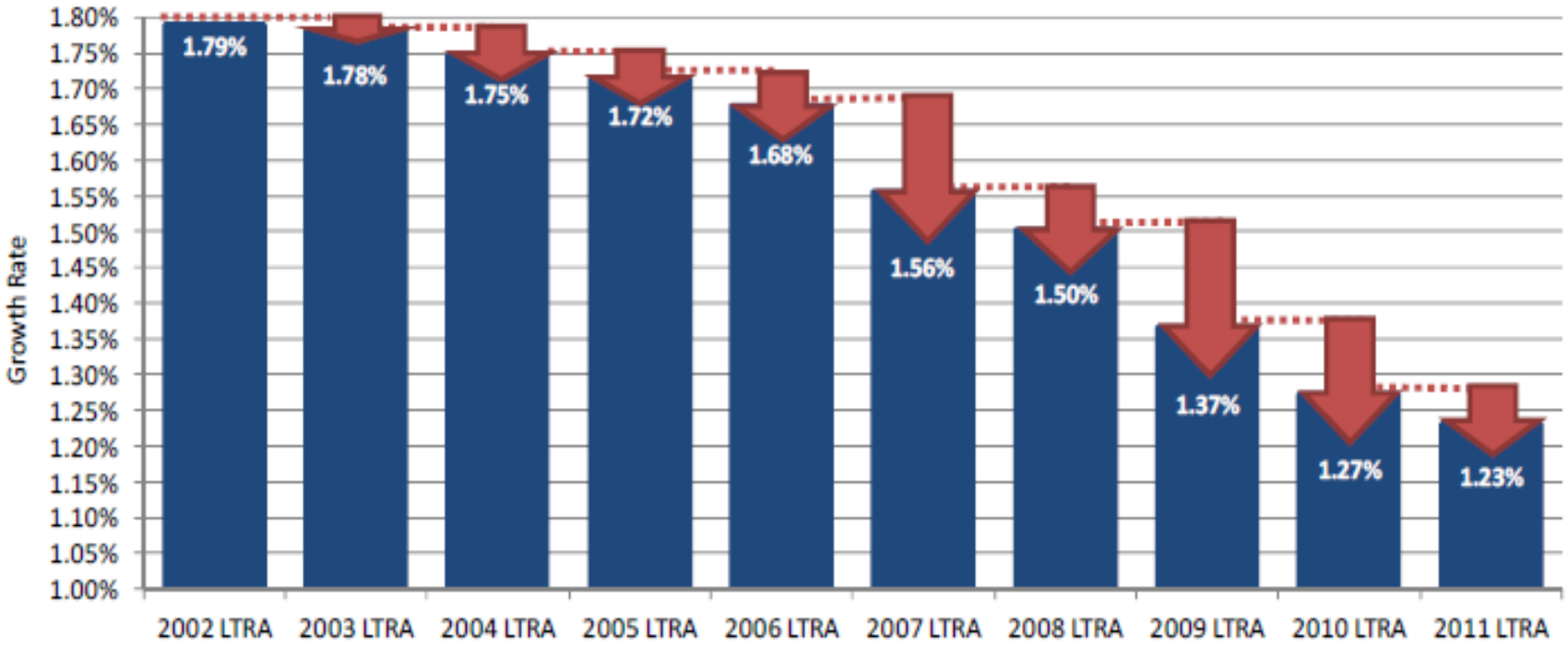
The commercial sector leads growth through 2035, mirroring the deindustrialization of the economy



Source: EIA, 2012 Annual Energy Outlook

Long term forecasts of peak demand are on a downward trajectory

Comparison of Annual Average Growth Rates for NERC-Wide Summer Peak Demand



Source: NERC, 2011 Long Term Reliability Assessment

Five forces are creating the new normal

1. **Weak economy**
2. **Demand-side management**
3. **Codes and standards**
4. **Distributed generation**
5. **Fuel switching**

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The recession reduced demand and the tepid recovery slowed *growth* in demand

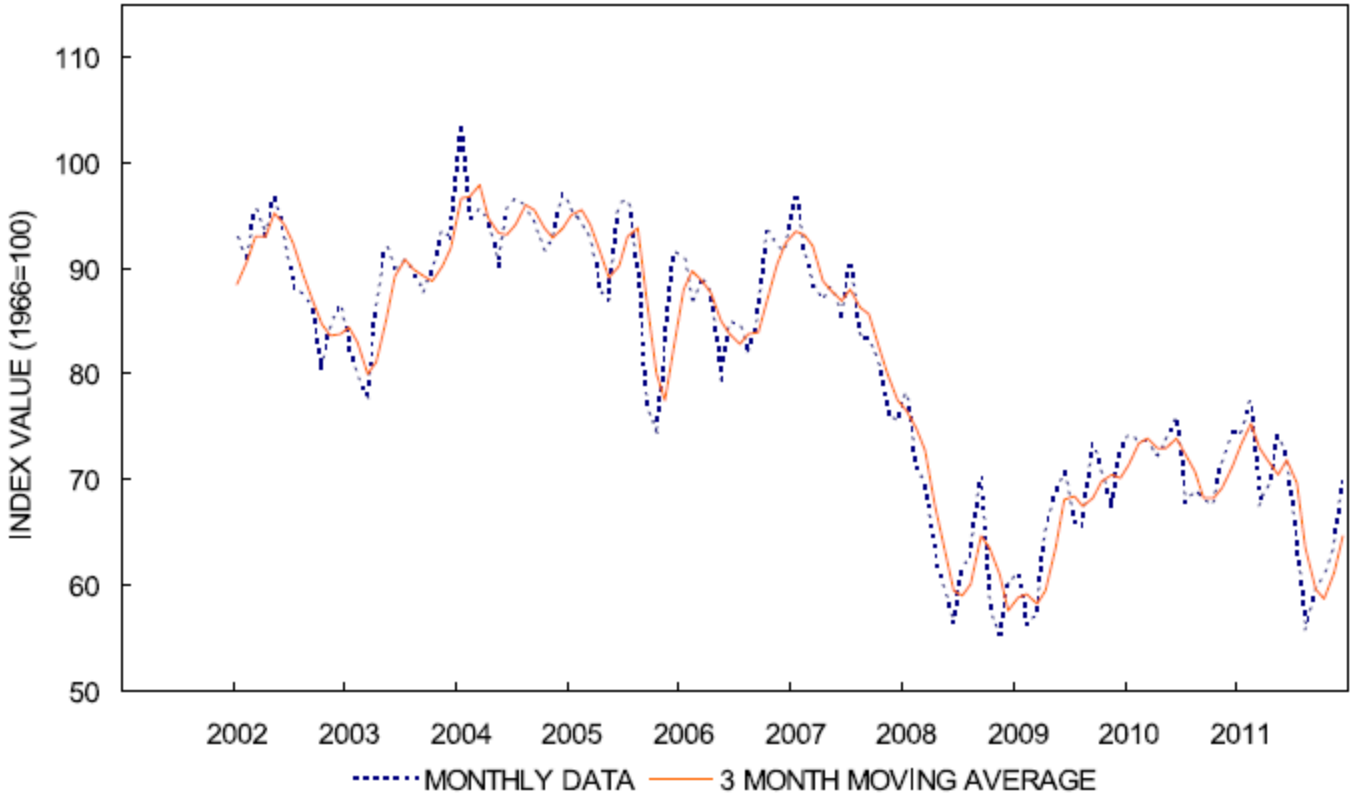
- According to the EIA, the 2008-2009 economic recession caused a significant drop in electricity demand and we have only partially recovered from this drop
- According to NERC, the “pace and shape” of the economic recovery will dramatically influence electricity demand
- The exception seems to be the Motley Fool, which noted recently that electric utilities produce “something we use regardless of economic conditions.”

Some of the recessionary impacts may be permanent

- Businesses have closed completely or relocated offshore
- People are unemployed, underemployed, or underpaid – thus reducing electric consumption and the purchase of electricity consuming appliances
- The tepid recovery has engendered a new psychology of frugality
  - Forecasters find that even after they put actual economic growth rates in their models and back cast, they are still over estimating demand
  - Consumer demand curves appear to have shifted inwards

Consumer confidence continues to be a drag on consumer spending

Index of Consumer Sentiment – Recent Changes



Source: University of Michigan Survey of Consumers

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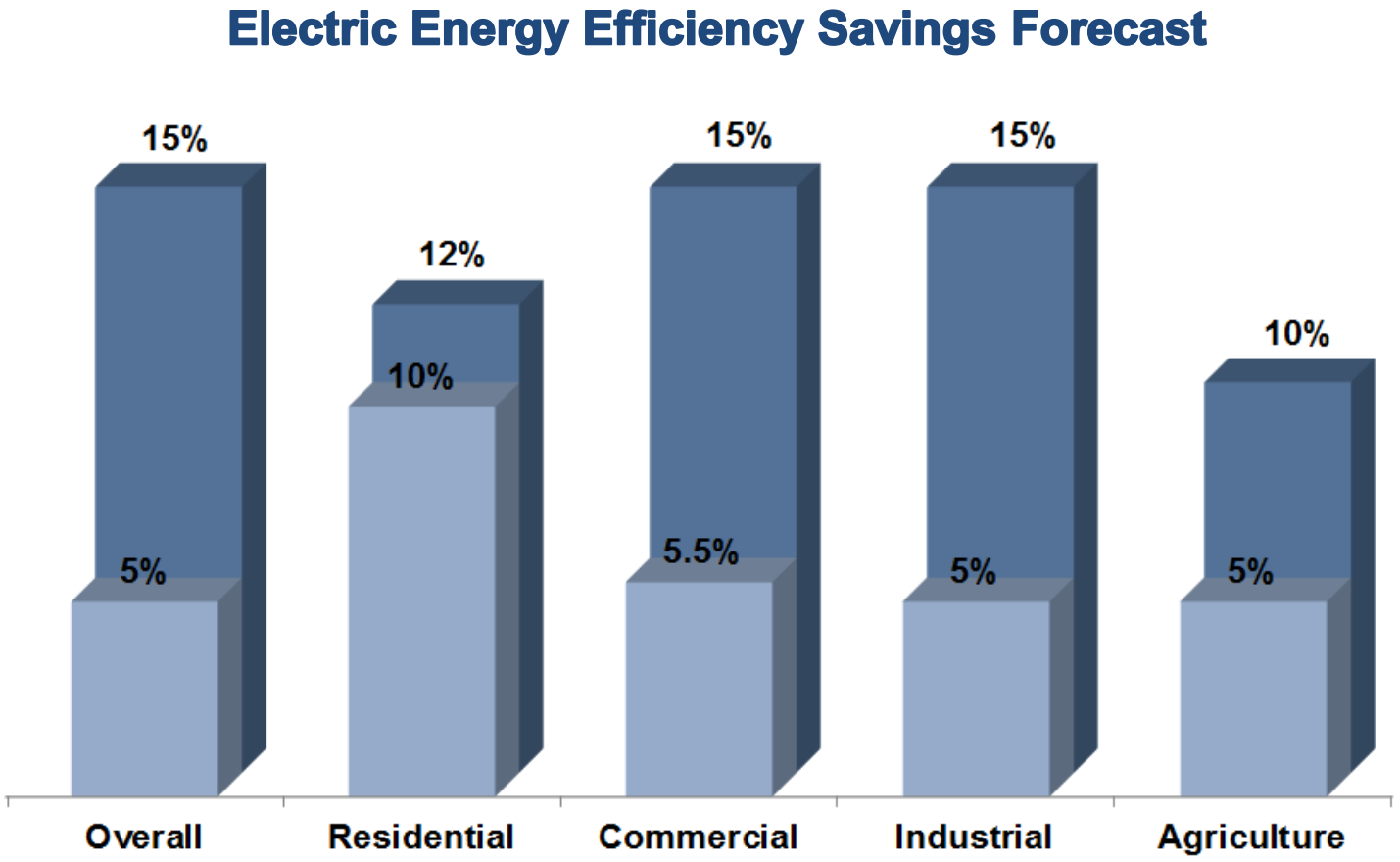
Demand-side management (DSM) contributes to reduced peak demand and electric energy consumption

- The drivers for DSM are increasingly environmental in nature, being driven by concerns about climate change
- All areas in NERC's forecast are expecting increases in DSM over the next 10 years
  - Across the whole forecast, DSM is projected to hit 55,000 MW by 2021 or 4.5% of the on-peak resource portfolio

Source: NERC, 2011 Long Term Reliability Assessment

Brattle's survey of 50 experts shows that energy efficiency is likely to have a big impact

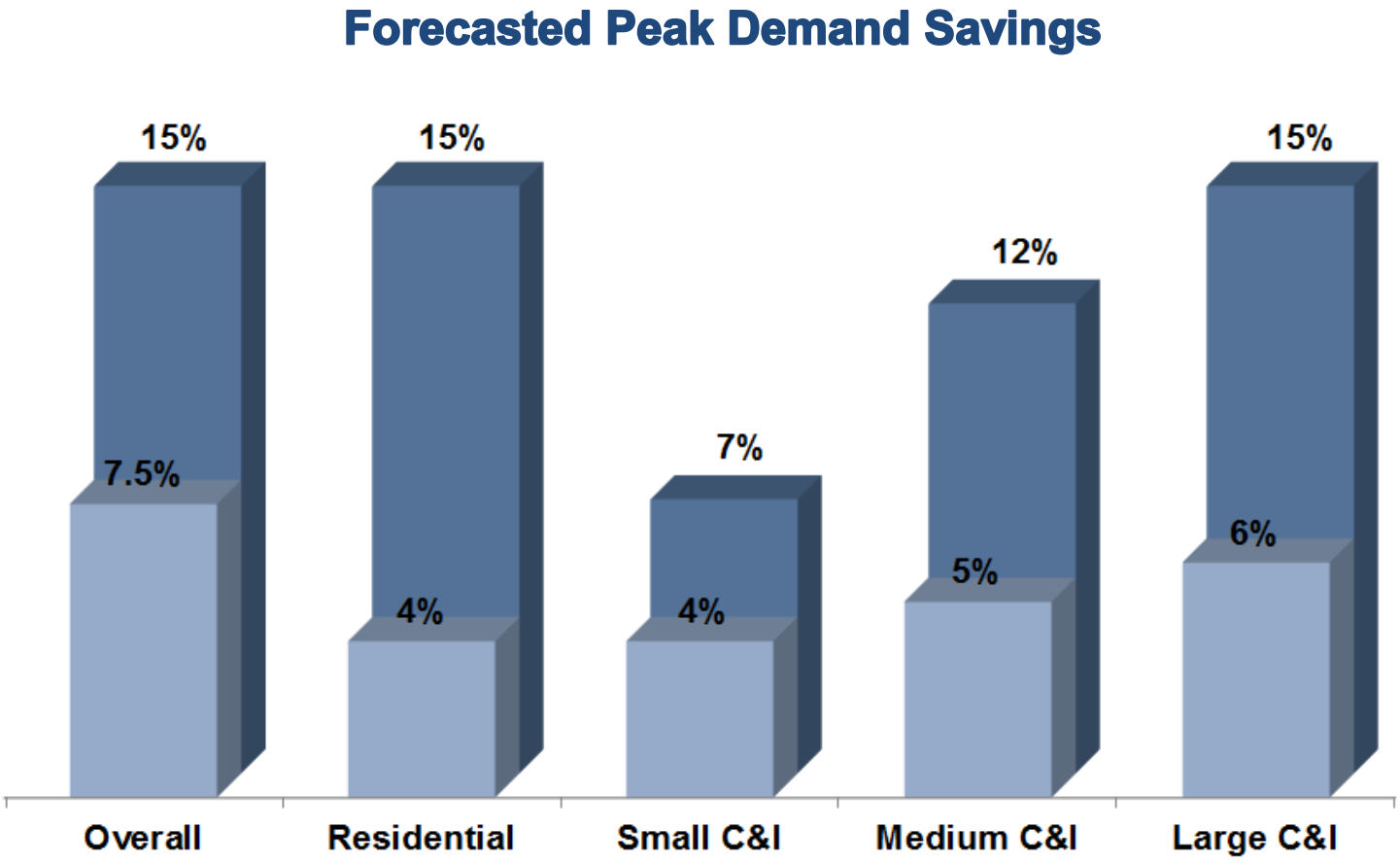


Median of Low and High Estimates
10 Years From Now

Behavior-modifying programs are the newest element in the energy efficiency portfolio

- In the new generation of consumers, conservation is not just a personal virtue
- Web portals and social media are raising the energy consciousness of consumers
- About 7 million households in North America are saving 1.4 billion kWh of electricity per year due to home energy reports that compare their monthly usage with a peer group

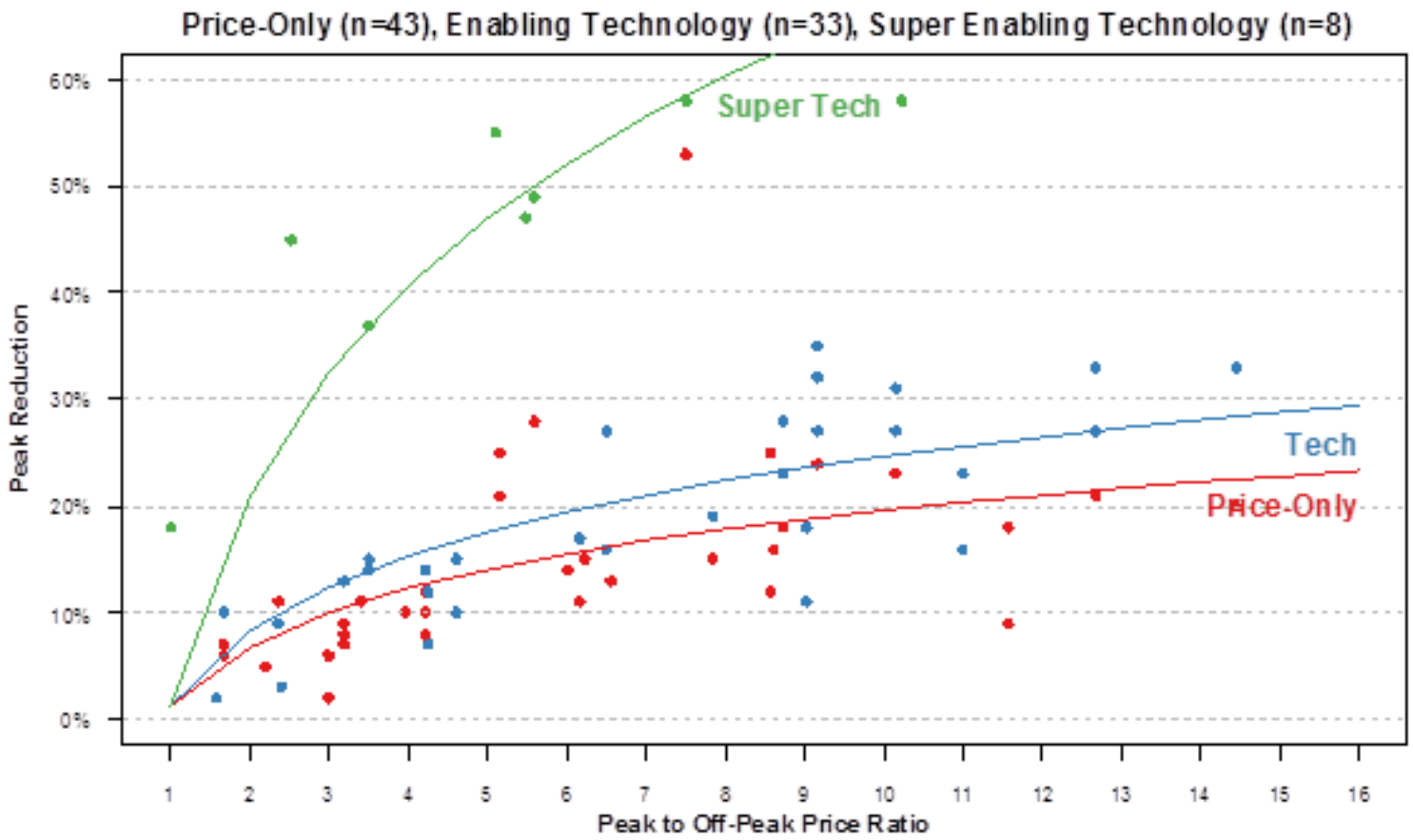
The *Brattle* survey indicates that demand response is expected to lower peak demand by 7.5% to 15%



Median Low and Median High Estimates
10 Years From Now

Dynamic pricing is rolling out, spurred on by pilots and rapid smart meter deployment

The Arc of Price Responsiveness



Faruqui-Palmer, The Discovery of Price Responsiveness, 2012

Five forces are creating the new normal

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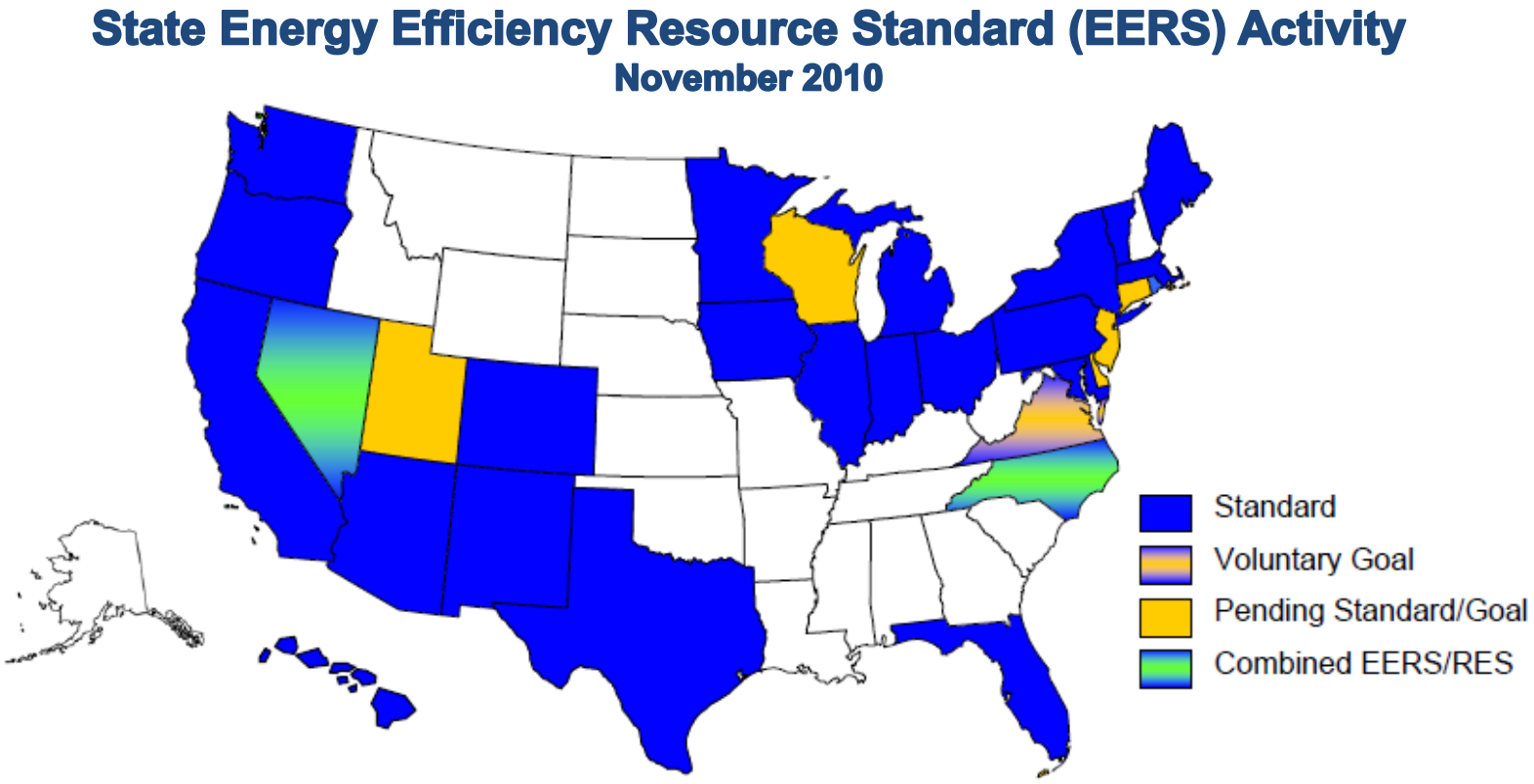
Several states have passed laws either requiring or promoting energy efficiency

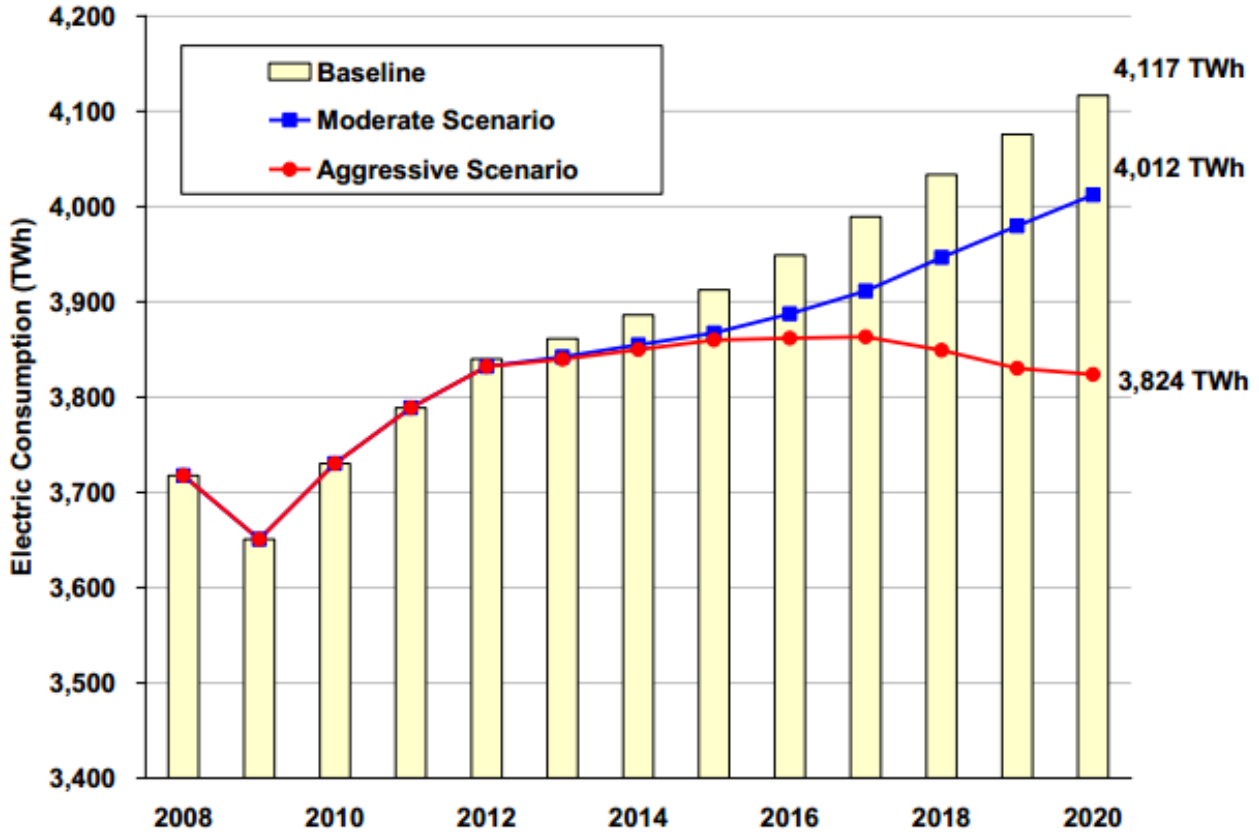


Twenty-four states have enacted energy savings goals, or Energy Efficiency Resource Standards (EERS), through legislation and several states have a pending EERS

Source: Regulatory Assistance Project 2011

New codes and standards could dramatically decrease baseline energy consumption

Impact of Codes and Standards on Total U.S. Electricity Consumption (TWh)



Source: IEE, Assessment of Electricity Savings Achievable through New Appliance/Equipment Efficiency Standards and Building Efficiency Codes

The EIA is attributing declining per capita residential electricity sales to EISA 2007

- New federal lighting standards were outlined in the Energy Independence and Security Act (EISA) of 2007, which went into effect on January 1, 2012
  - General-service lamps providing 310 to 2,600 lumens of light are required to consume 30% less energy than typical incandescent bulbs and compact fluorescent and LED lamps replace low-efficacy incandescent lamps
- The EIA forecasts that lighting per household in 2035 will be 827 kWh per year, or 47% below the 2010 level

Source: EIA, 2012 Annual Energy Outlook

Five forces are creating the new normal

1. Weak economy
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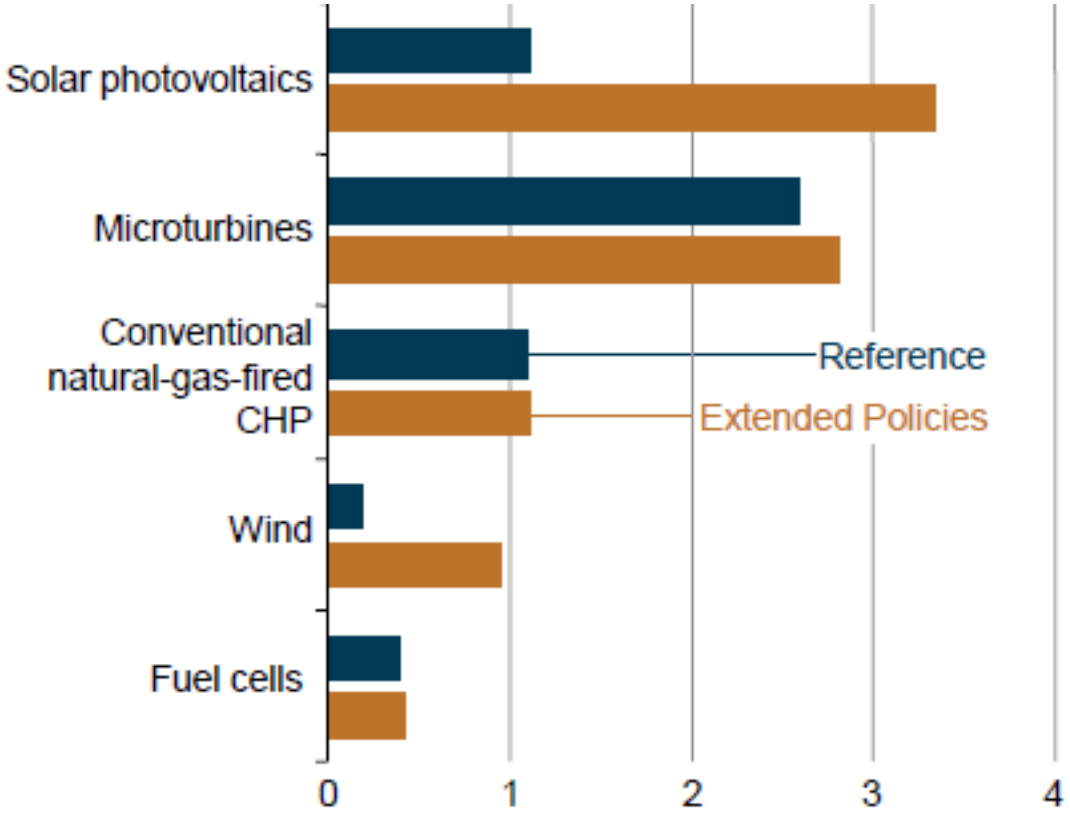
4. **Distributed generation**
5. Fuel switching

Distributed generation with net metering could lower demand significantly

- Distributed generation (DG) – including rooftop solar PV – is anything that produces electricity (or other form of energy, such as water heating) on the customer side of the meter
- The growth in DG depends on:
  - retail cost of electricity – ***Increasing***
  - cost of on-site generation – ***Decreasing***
  - net metering regulations – ***Varies by state***
  - storms and outages – ***More frequent than before***

The EIA predicts significant increases in distributed generation, especially with more investment tax credits

Additions to Electricity Generation Capacity in the Commercial Sector in Two Cases, 2010 – 2035 (Gigawatts)



Source: EIA, 2012 Annual Energy Outlook

Net metering enables distributed generation to expand

- In 2003, there were less than 7,000 U.S. customers on net metering
- By 2010, there were 156,000 (roughly half in California)
- In 2010, that amounts to 0.1% of total U.S. electricity sales
- In California, the 5% cap is predicted to be reached by 2015

Source: Net Metering: A Worrisome Trend, The International Energy Newsletter, July 2012.

With distributed generation, net-zero energy homes become a reality

- In Austin, Texas, the Zero Energy Capable Homes program requires that new single-family homes be net-zero energy capable by 2015
- The largest community of net-zero homes in the U.S. is rising in West Village at UC Davis in California
- The California Energy Commission has called for all new residential construction to be zero net energy by 2020 and for all new commercial construction to be zero net energy by 2030
- *If all of this comes to pass, who will pay for the grid?*

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More customers may switch away from electricity to natural gas

- Lower gas prices from fracking could result in people shifting away from electricity and towards gas for heating
- Oak Ridge National Laboratory has developed gas-fired heat pumps, which could supply both heating and cooling
- Higher cost of electricity would further encourage customers to switch away from electricity

A host of other forces are suppressing demand

- Disruptive end-use technologies
  - An *iEverything* appliance, Green Buttons, and smart phones
- New entrants are working to disintermediate utilities from consumers
- Federal and state legislation requires lower carbon emissions
- Looming water shortages and heat waves evoke the scenarios laid out in *The Limits to Growth* by the Club of Rome in 1972

Of course, other factors may lead to higher demand growth

- Digitalization of homes and businesses
- The advent of plug-in electric vehicles
- Increasing home size
- Aging baby-boomers spending more time at home
- Stepped-up migration to warmer states, leading to increased demand for space cooling

A random walk down *Forecast Country*

- **California**
  - New home construction has collapsed
  - Manufacturers are resorting to self-generation and microturbines, causing the share of electricity sold to manufacturing to drop from 33% to 10%
  - Advanced metering has rolled out and dynamic pricing is following suit
  - An interfaith group is pushing for more renewable energy in the name of God
  - NRG will be funding the installation of electric car charging stations
- **Midwest**
  - Weather-adjusted use per household has dropped in the third quarter for the past two years
- **New England**
  - Both energy efficiency and demand response can bid into forward capacity markets

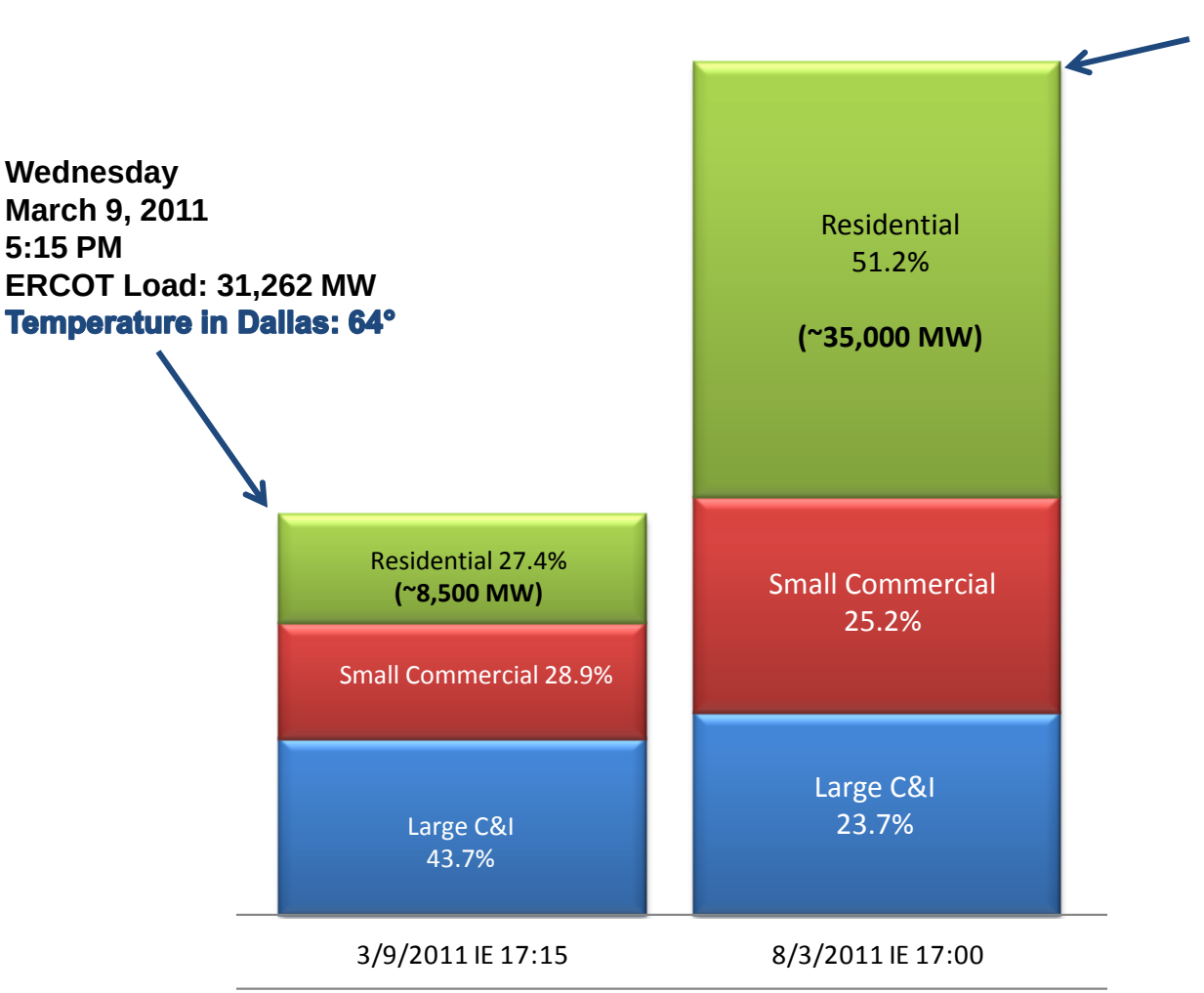
A random walk – continued 2

- **New York**
  - Housing construction has slowed down, possibly due to delayed family formation
- **Pacific Northwest**
  - Industrial self-generation is rising, old industries are shutting down, and new industries, such as server farms are not creating many jobs
- **PJM**
  - Price responsive demand has been given the green light by FERC
  - Advanced metering is rolling out
  - More than 2 million customers will be on dynamic pricing in the next few years

A random walk – continued 3

- **Southwest**
  - Was hit hard by the collapse in the housing market, along with declining population growth
- **Tennessee Valley**
  - Homeowners are taking actions to save money, because of all the buzz about energy efficiency

And then there is Texas, where the mass market is a prime target for demand response



- Customer class breakdown is for competitive choice areas; percentages are extrapolated for munis and co-ops to achieve region-wide estimate
- Large C&I are IDR Meter Required (>700kW)

Source: ERCOT

Demand growth will continue to show significant regional variation, as it has in the past year

	2011 Forecast	2011 Actual	2012 Forecast	Forecast % Change	Demand Decrease / Demand Increase
ERCOT	64,964	68,416	66,076	1.71%	1,112
NPCC-New York (NYISO)	32,712	33,865	33,295	1.78%	583
SPP	53,512	55,352	54,051	1.01%	539
SERC-W	25,101	25,585	25,403	1.20%	302
WECC-Total	149,148	147,299	149,173	0.02%	25
SERC-E	43,249	43,253	43,255	0.01%	6
MRO-SaskPower	3,045	2,988	3,044	-0.05%	-1
MRO-Manitoba	3,166	3,378	3,143	-0.73%	-23
NPCC-Ontario	23,561	25,450	23,409	-0.65%	-152
NPCC-Maritimes	3,553	3,329	3,392	-4.53%	-161
MRO-MAPP	5,087	4,732	4,799	-5.67%	-288
NPCC-Québec	21,283	21,354	20,988	-1.39%	-295
SERC-SE	49,314	50,309	48,895	-0.85%	-419
FRCC	46,091	44,798	45,613	-1.04%	-478
NPCC-New England (ISO-NE)	27,550	33,865	26,462	-3.95%	-1,088
PJM & MISO	248,513	257,135	246,884	-0.66%	-1,629
SERC-N	46,846	45,579	45,102	-3.72%	-1,744

NERC, 2012 Summer Reliability Assessment

When all is said and done

- The drop in demand growth seems to be permanent, not transitory
- It would be a mistake to attribute the drop just to the recession and assume that it will go away once “normal” economic activity resumes
- As seen on Slide 2, the drop is consistent with the arc of history
- The *new normal* may be growth at about half of the pre-recession value, in the 0.7% to 0.9 % a year range

Survival in a sub one-percent growth world calls for new thinking

- Both utilities and regulators have to come up with new solutions that delink earnings from sales
- As Fox-Penner argues in *Smart Power*, utilities should consider becoming smart wires companies or integrated energy service companies
- But for that to happen, enlightened regulators will have to rewrite the rules of the game
- For the new rules to work, it will be necessary to involve those who intervene in utility rate cases, especially consumer advocates

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Biographical Information

ahmad.faruqui@
brattle.com

201 Mission Street,
Suite 2800
San Francisco, CA
94105

Dr. Faruqui has consulted on customer strategy with more than 50 utilities and transmission system operators and appeared before a dozen state and provincial commissions and legislative bodies. He has advised two dozen clients on demand forecasting issues.

In the past decade, he has developed models for forecasting monthly and hourly loads. He helped develop an hourly load forecasting model to assist a competitive wholesaler in bidding for default service. For a utility, he diagnosed why energy sales were below forecasts even after adjusting for the effects of the economy. He assisted a transmission system operator understand why peak demand was being under-forecast by a large amount. And he assisted a regulated provider of steam analyze the customer's decision to switch from purchasing steam to self-generating of steam.

More recently, Dr. Faruqui has been involved in the estimation of hourly, daily and monthly demand models in the context of dynamic pricing. Dr. Faruqui has managed the design and evaluation of large-scale dynamic pricing experiments in California, Connecticut, Florida, Illinois, Maryland and Michigan two of which have won awards.

His analysis of the factors that influence customer demand has been cited in publications such as The Economist, The New York Times, and USA Today and he has appeared on Fox News and National Public Radio. The author, co-author or editor of four books and more than 150 articles, papers and reports on efficient energy use, he holds a Ph.D. in economics and an M.A. in agricultural economics from The University of California at Davis, where he was a Regents Fellow.

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- Regulatory Finance, Cost of Capital
- Demand Response and Energy Efficiency
- Electricity Market Modeling
- Energy Asset Valuation
- Energy Contract Litigation
- Environmental Compliance
- Fuel and Power Procurement
- Incentive Regulation
- Rate Design and Cost Allocation
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- Renewables
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The Brattle Group

www.brattle.com

North America

Cambridge, MA
+1.617.864.7900

Washington, DC
+1.202.955.5050

San Francisco, CA
+1.415.217.1000

Europe

London, England
+44.20.7406.7900

Madrid, Spain
+34.91.418.69.70

Rome, Italy
+39.06.48.888.10