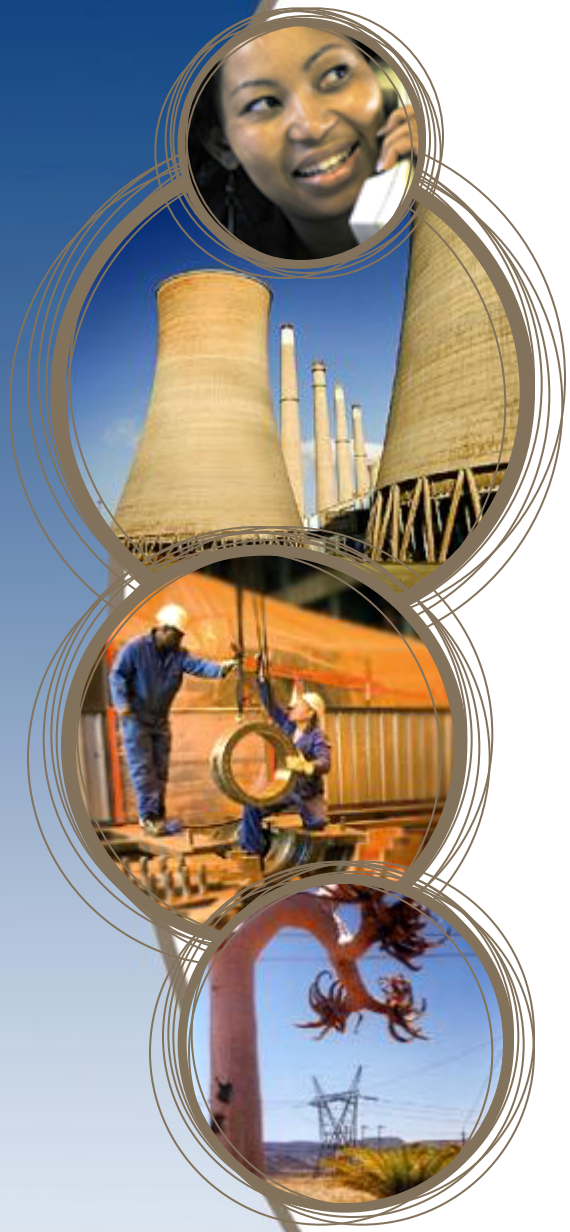
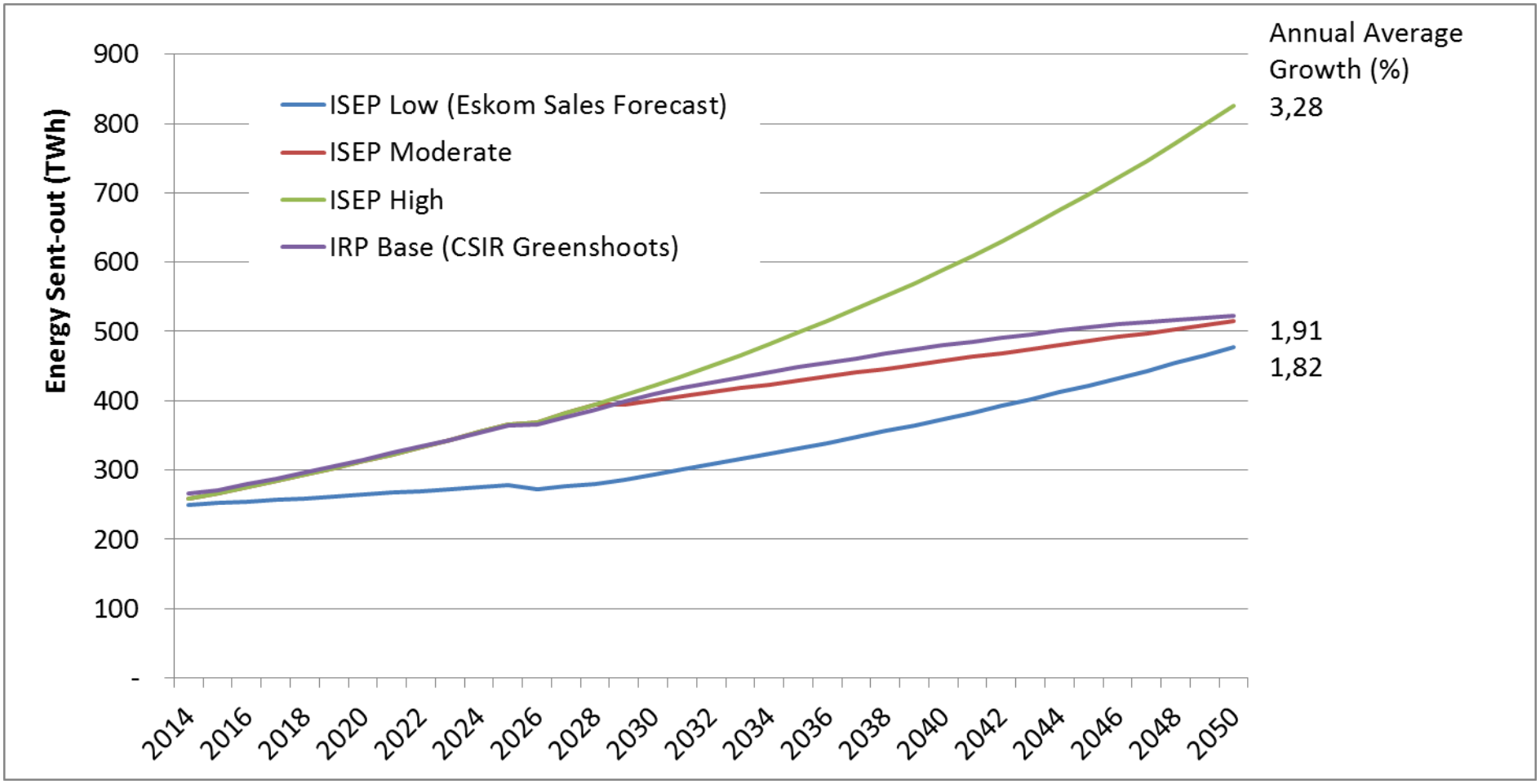


Load Forecasting Seminar

Barry MacColl

Load Forecasting…cone of uncertainty



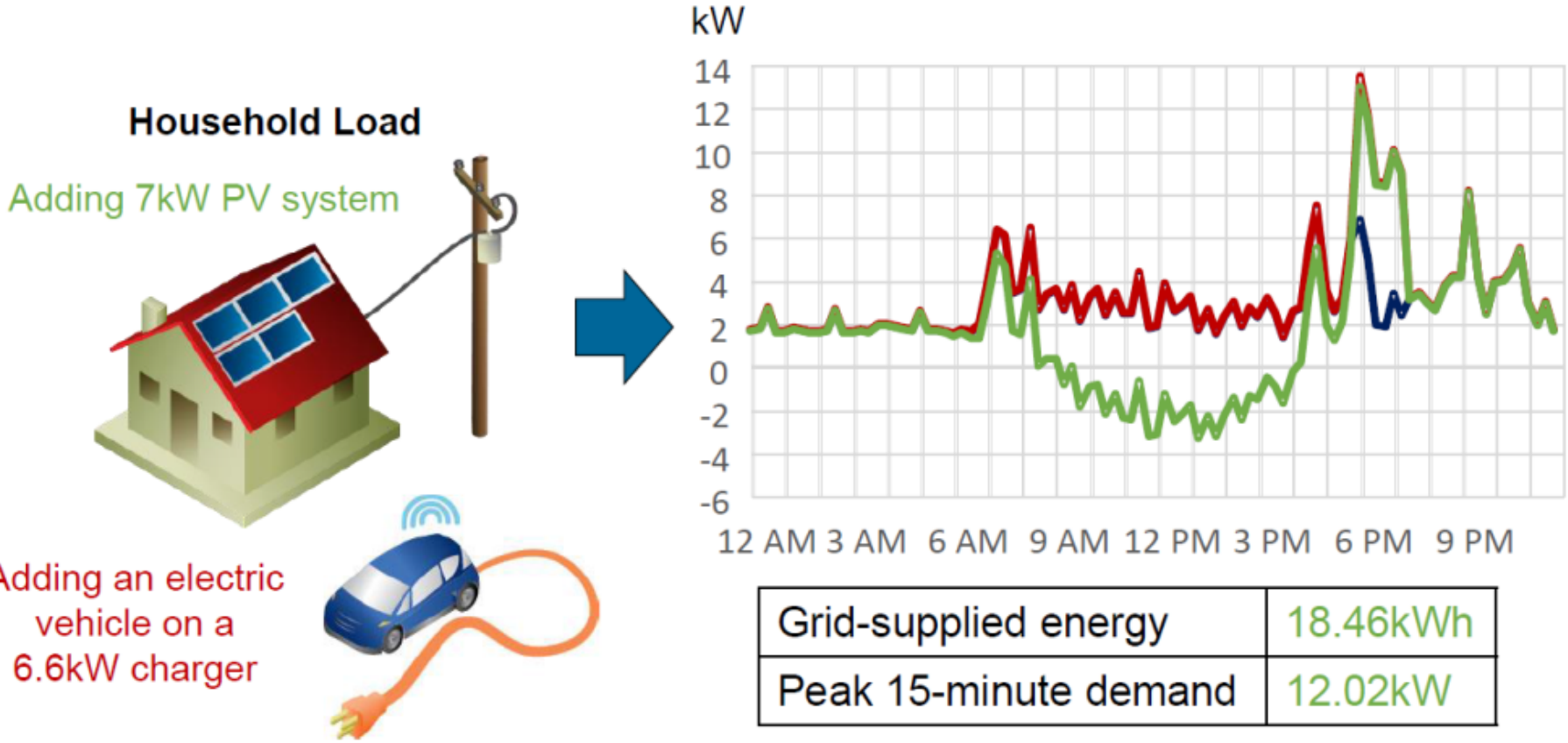
- ISEP Base Case – ISEP Moderate (March 2014 Graph)

2014 Technology Innovation Program

Strategic Programs

Power Generation	Materials
	Nondestructive Evaluation
	Nuclear Fuel Technology
	Renewable Energy and Integration
Power Delivery and Utilization	**Distributed Energy Resources & Integration**
	Energy Efficiency
	Grid Transformation
	Power Electronics
Environmental	Carbon Capture
	Environmental Impacts of the Future Power System
	Near Zero Emissions
	Water Use and Availability
Cross-Cutting R&D	Concrete
	Cyber Security
	Sensors & Operations

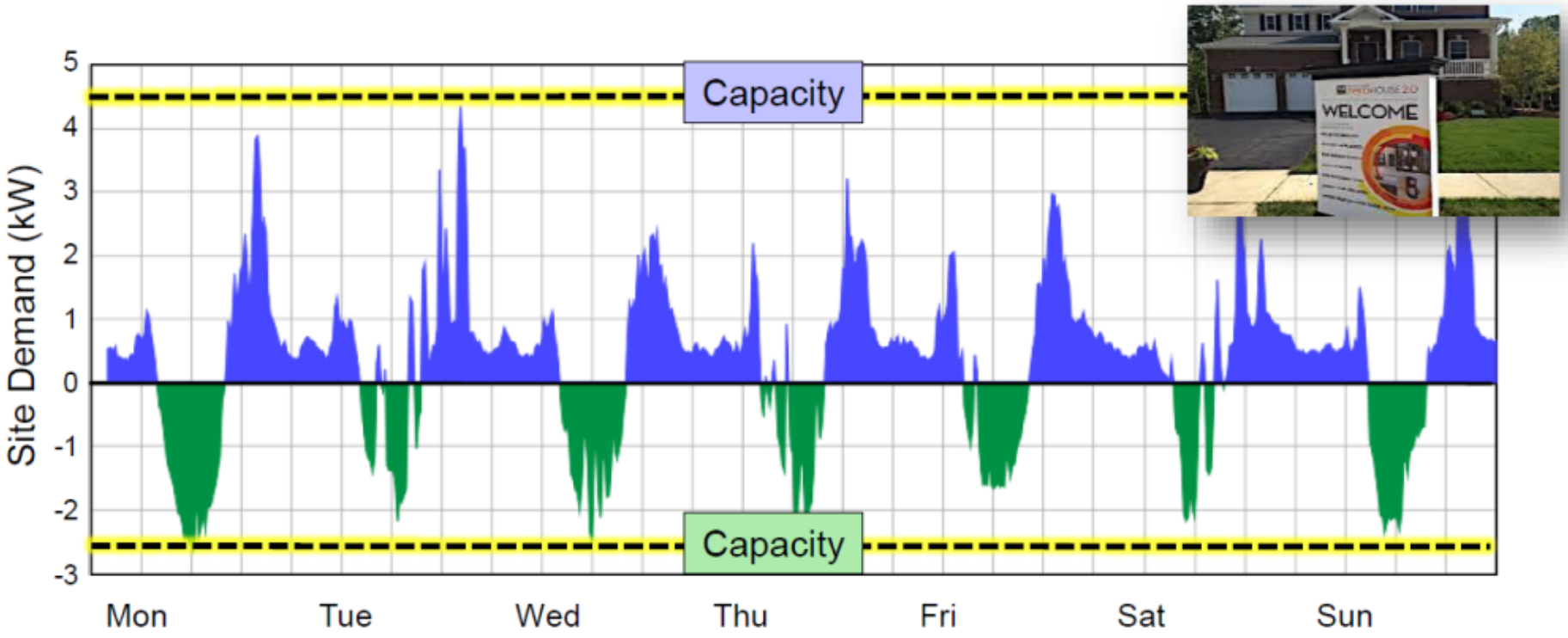
New Residential Resources



Grid-supplied energy	18.46kWh
Peak 15-minute demand	12.02kW

- New types of sources and loads may alter required capacity and energy
- Lack of diversity in generation/use increases capacity requirements

Zero Energy Home but Not Zero Capacity Home

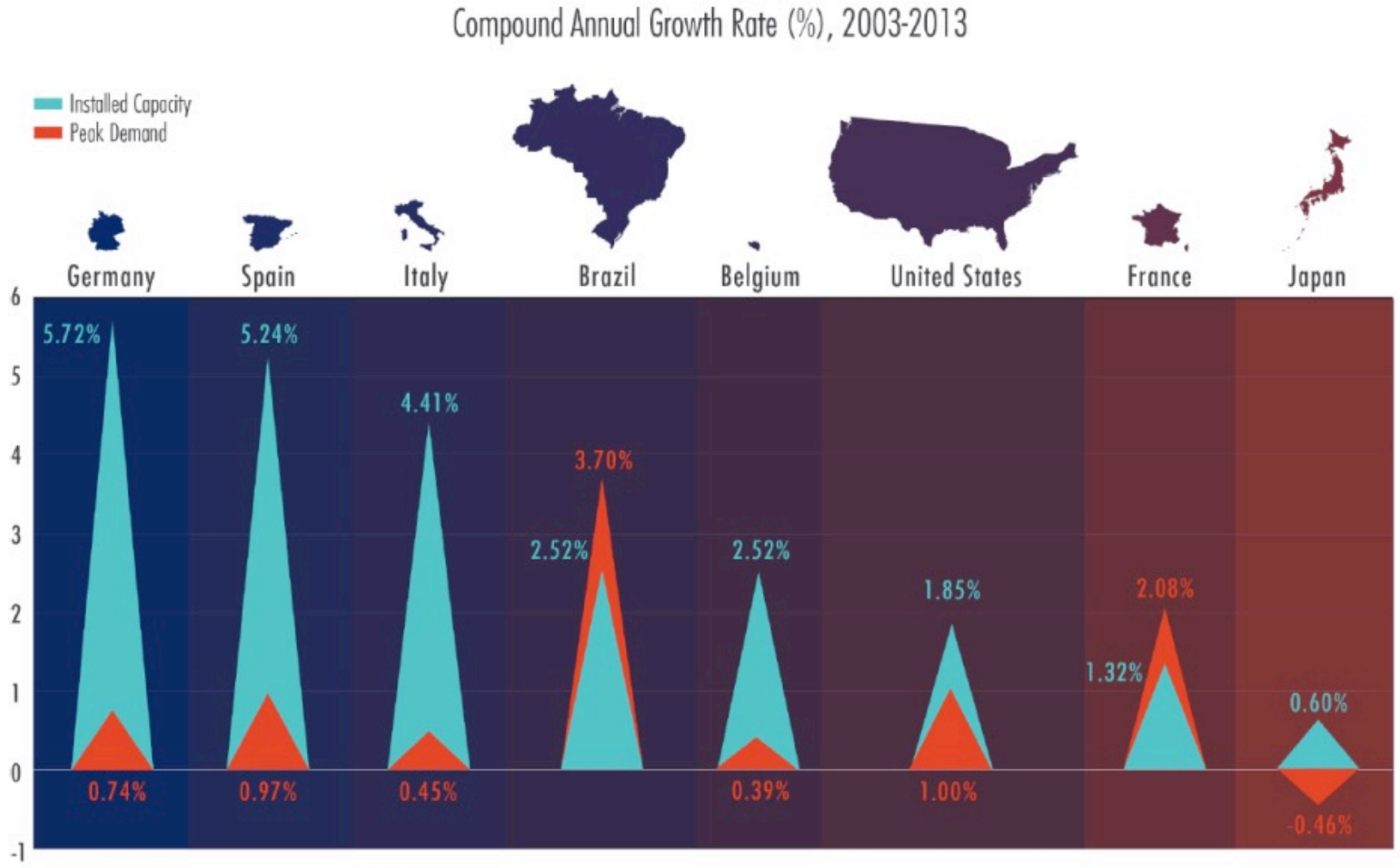


Customer Sited Generation Will Impact Local and System Level T&D Infrastructure Planning

EPRI ELECTRIC POWER RESEARCH INSTITUTE

Diverging Trend

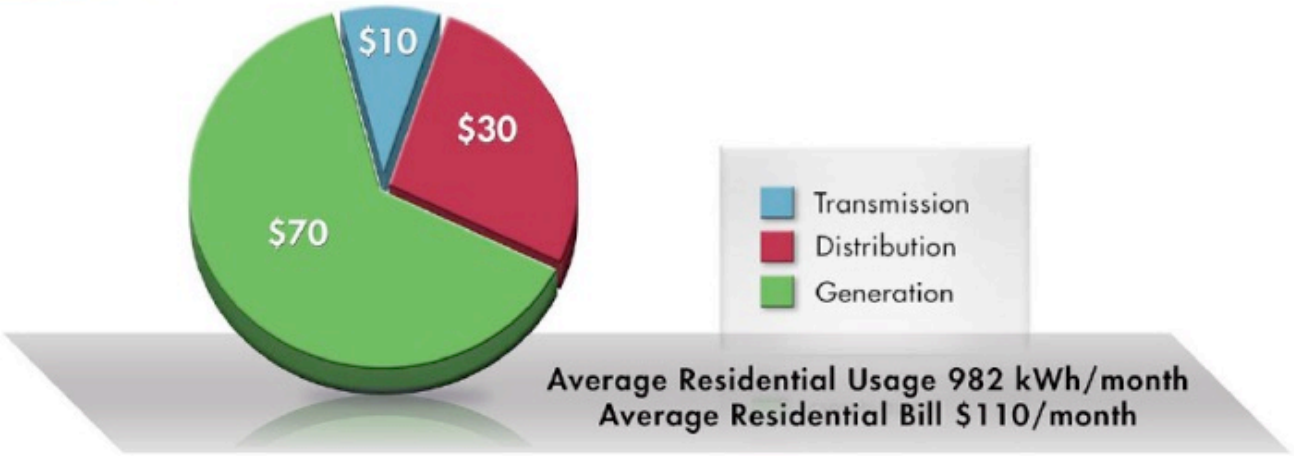
Installed Capacity Growing Faster than Demand

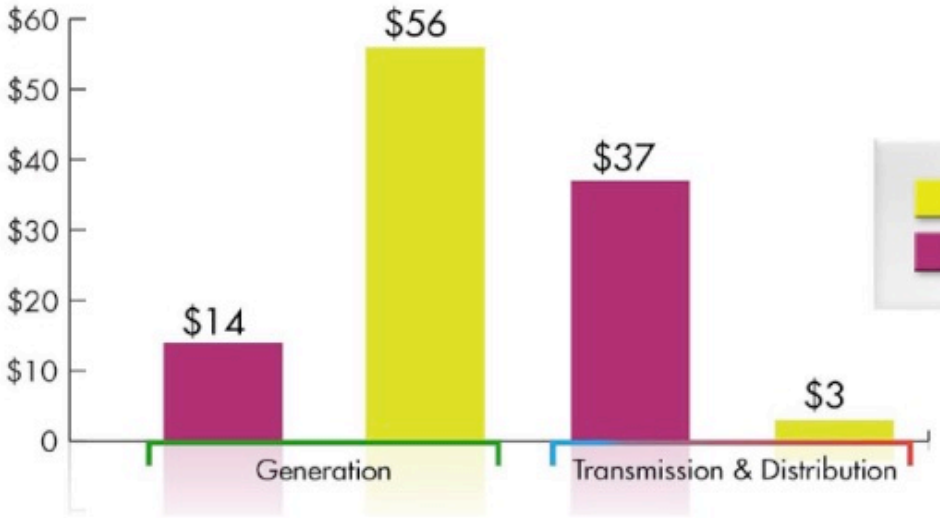


Data Source: EIA

EPRI ELECTRIC POWER RESEARCH INSTITUTE

Recap: Integrated Grid Paper – Cost to Deliver Capacity





High level ballpark national assessment based on EIA 2011 data

EPRI ELECTRIC POWER RESEARCH INSTITUTE

1923-2013

EPRI | ELECTRIC POWER RESEARCH INSTITUTE

Load Forecasting in the New Era of Uncertainty

Omar Siddiqui

Senior Technical Executive

Research Advisory Committee

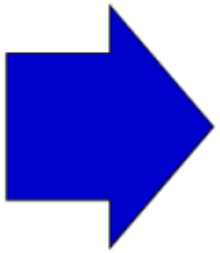
Phoenix, Arizona

October 28, 2014

Load Forecasting – The Story in Brief

Status Quo Methods

- Econometric regressions of variables highly correlated to electricity demand
  - Population
  - Weather
  - Economics
- Decades of successful practice in utility planning
  - Short term (week ahead)
  - Long term (years ahead)



Challenges

- Traditional variables becoming less correlated
- Disruptive technologies gaining effect on load
  - Rapid pace of change
  - Sparse data or experience with these new variables
- Demand becoming more variable, *less predictable*
- Unprecedented changes

Implication

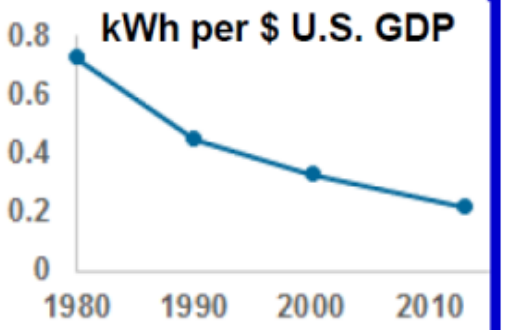
Load forecasting methods must adapt to new era of uncertainty or risk continued divergence from reality and sub-optimal investment and planning decisions

New Era of Load Uncertainty – Macro Drivers

Structural Changes in Economy

Load growth decoupling from economic growth

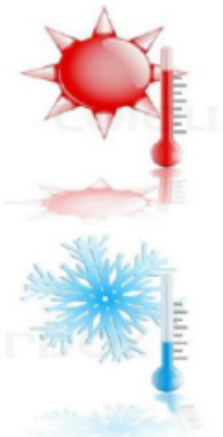
Sustained effect of recession: "new normal" stagnation



Weather Anomalies

Increasing frequency of extreme weather occurrences

Diminishing predictive value of historical weather data



Peak Demand Outpacing Energy

U.S. 1.2% peak demand growth vs. 0.8% energy growth (next 10 years)

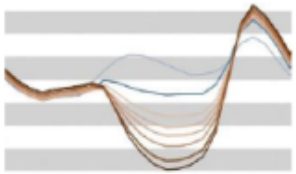
Greater penetration of central air conditioning

Localized needle peak phenomenon

Ramping for Renewables

Increasing solar and wind penetration puts pressure on other resources (supply and demand) to flex

"Duck curve" effect – steepening ramp rates



EPRI ELECTRIC POWER RESEARCH INSTITUTE

Disruptive Changes in Electricity End Use

Energy Efficiency

$6 Billion spent on EE programs in 2012 in U.S.

8 – 11% energy savings potential from EE programs in 2035 (EPRI)

Codes & Standards: 7% energy savings impact of EISA in 2030

Variable Speed Heat Pumps

Over 30% energy savings in EPRI field studies

Flexible operation for DR, but may *increase* peak demand at max loading conditions

Enhanced comfort and control

Consumer Electronics

Proliferation of chargeable devices

TVs more efficient, more ubiquitous; 2.9 TVs per home (2.5 people per home)

Power is the limiting factor

Energy Controls

Growth of sophisticated, intuitive devices and apps for energy and demand management

Reshaping load curves

Disruptive Changes in Electricity End Use (Cont'd)

Plug-in Electric Vehicles

PEV sales growing faster than hybrids a decade earlier

200,000+ PEVs sold in U.S.

Projected to exceed 5% of new vehicle sales by 2020

Solar Photovoltaic

More solar installed in U.S. in last 18 months than prior 30 years

5x increase projected in U.S. over next 3 years

New residential PV system installed in U.S. every 4 minutes

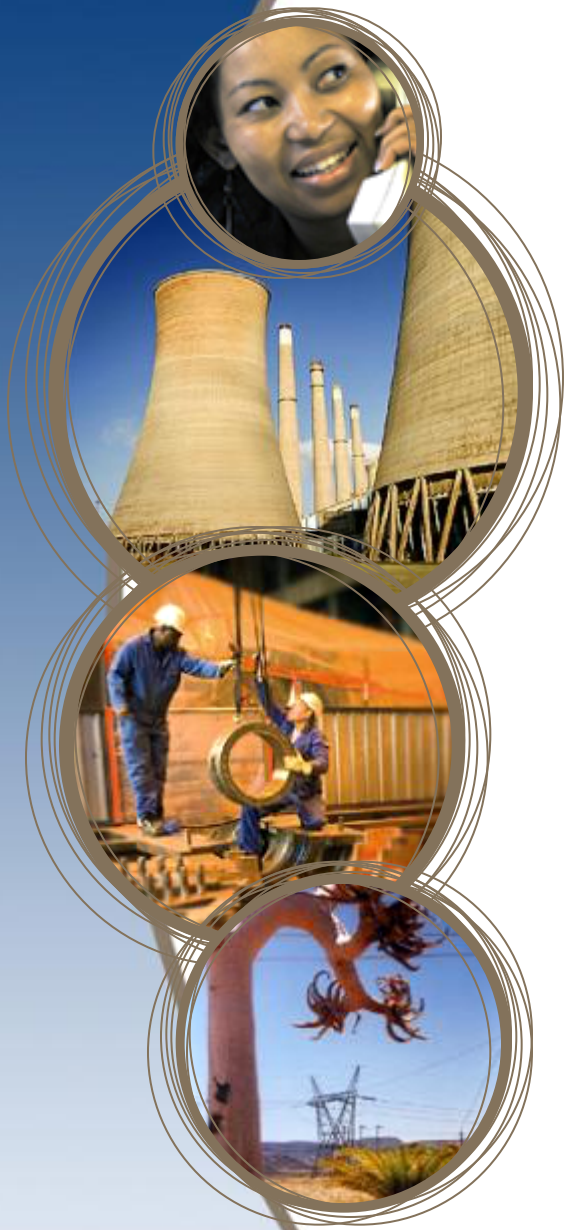
Capacity value – questionable

Electrification

Advances in electric process heating, separations, and heat pump technologies for emissions reduction and productivity improvement

Natural Gas DG

Impact of $4/MMBtu wholesale prices on economics of natural gas DG



Recommendations

EPRI Proposal – Industry Collaborative Project

Load Forecasting Methods for the New Era of Uncertainty

- Convene diverse expert forum
  - Utility
  - Academia
  - ISO/RTO
  - Consultants
- Review analytical challenges
- Evaluate innovative methods
- Identify and promulgate best practices
- EPRI ideal focal point for collaboration
  - Understand technological drivers
  - Modeling experience

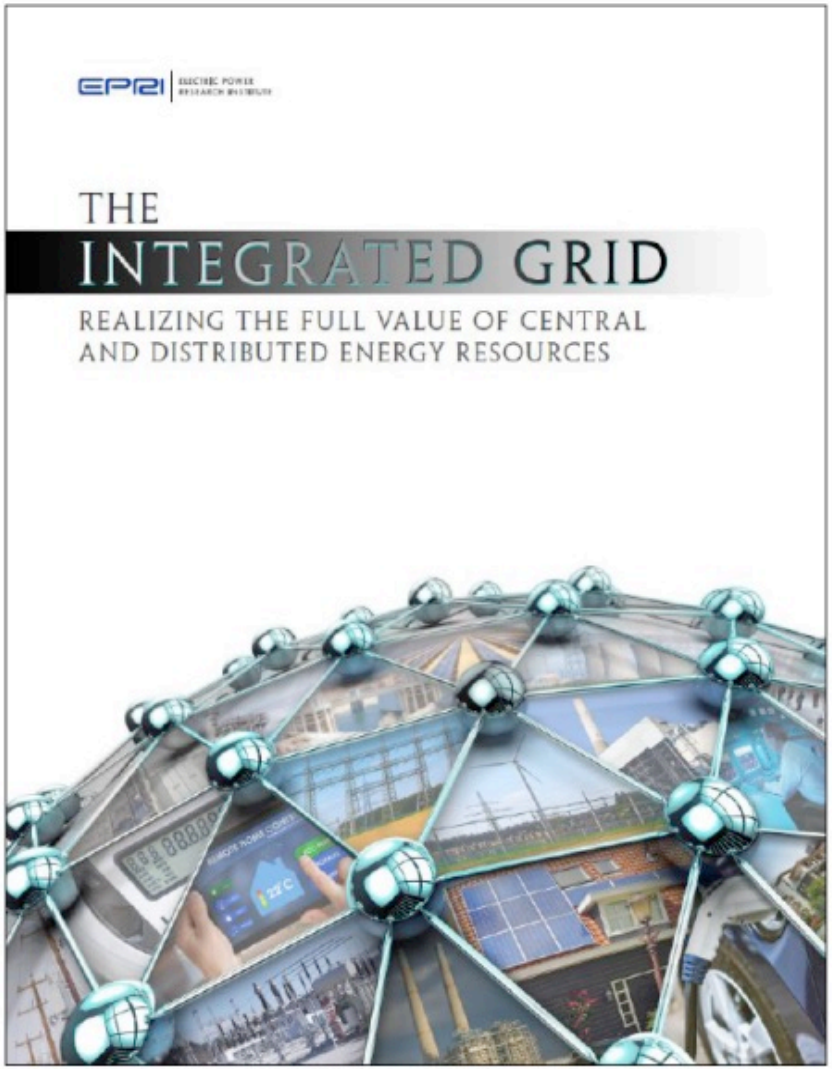
Next Steps

- **Identify experts in your organization to join expert forum**
- **Provide us with historical data and forecasts to sharpen our focus**

EPRI ELECTRIC POWER RESEARCH INSTITUTE

1923-2013

Integrated Grid



EPRI ELECTRIC POWER RESEARCH INSTITUTE

Bulk System Reliability

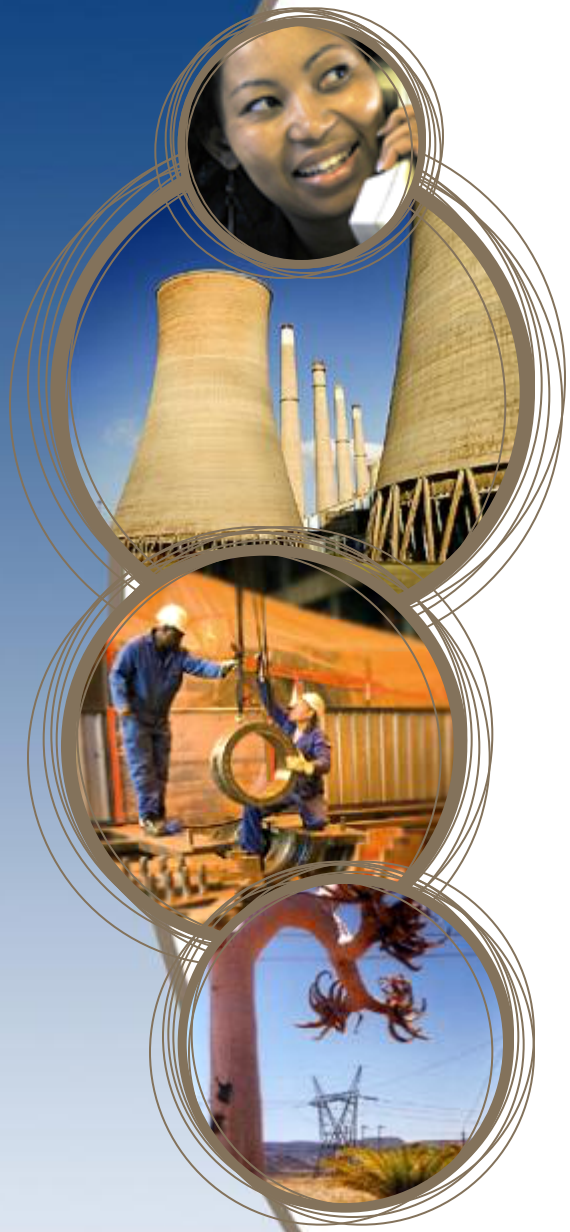
EPRI | ELECTRIC POWER RESEARCH INSTITUTE

Grid Reliability Considerations for High Levels of Demand Response

November 2013

		SYNCHRONOUS INTERCONNECTION						INVERTER-BASED INTERCONNECTION				DEMAND RESPONSE	
		Coal	Natural Gas Simple Cycle	Natural Gas Combined Cycle	Nuclear	...	Hydro	Wind	Grid Scale PV	Distributed PV	Battery Storage	Large (Industrial/ Commercial)	Small (Aggregated)
Volt/Var Control													
Frequency Control	Inertial Response												
	Primary Frequency Response (droop)												
	Regulation												
	Load Following/ Ramping												
	Dispatchable Energy												
	Spinning Reserve												
Short-term Availability													
Long-term Availability													
Black Start													

0 1 2 3 4 5



Thank You

Barry.maccoll@eskom.co.za