

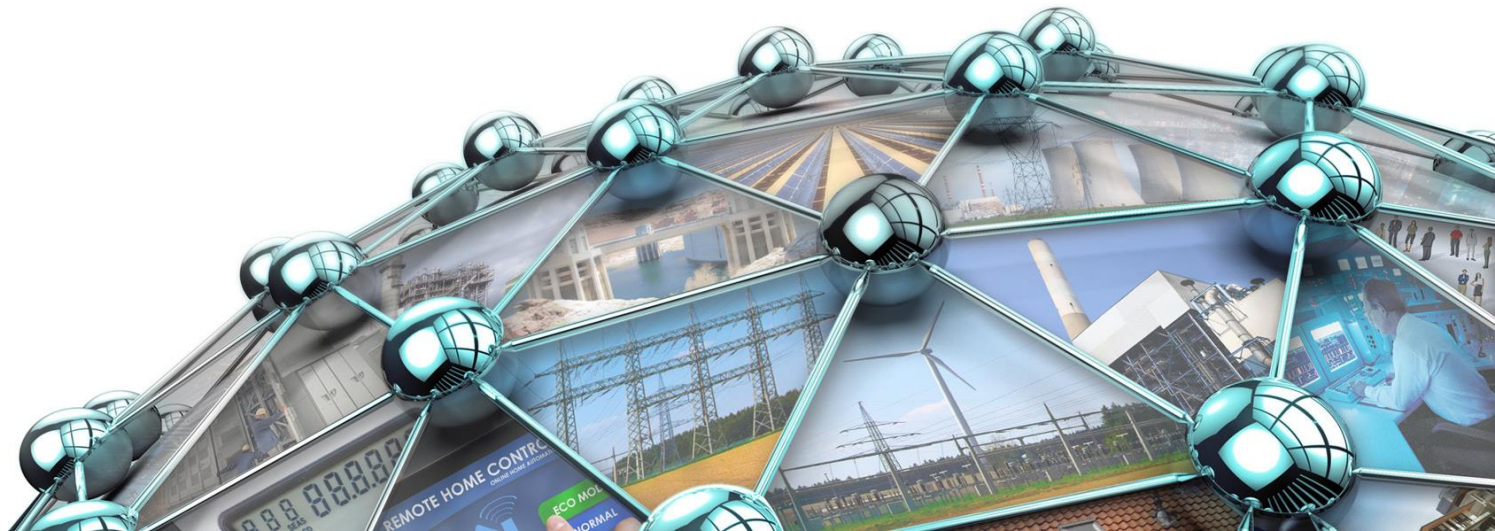
THE INTEGRATED GRID

REALIZING THE FULL VALUE OF CENTRAL
AND DISTRIBUTED ENERGY RESOURCES

Ron Schoff – Senior Program Manager, EPRI

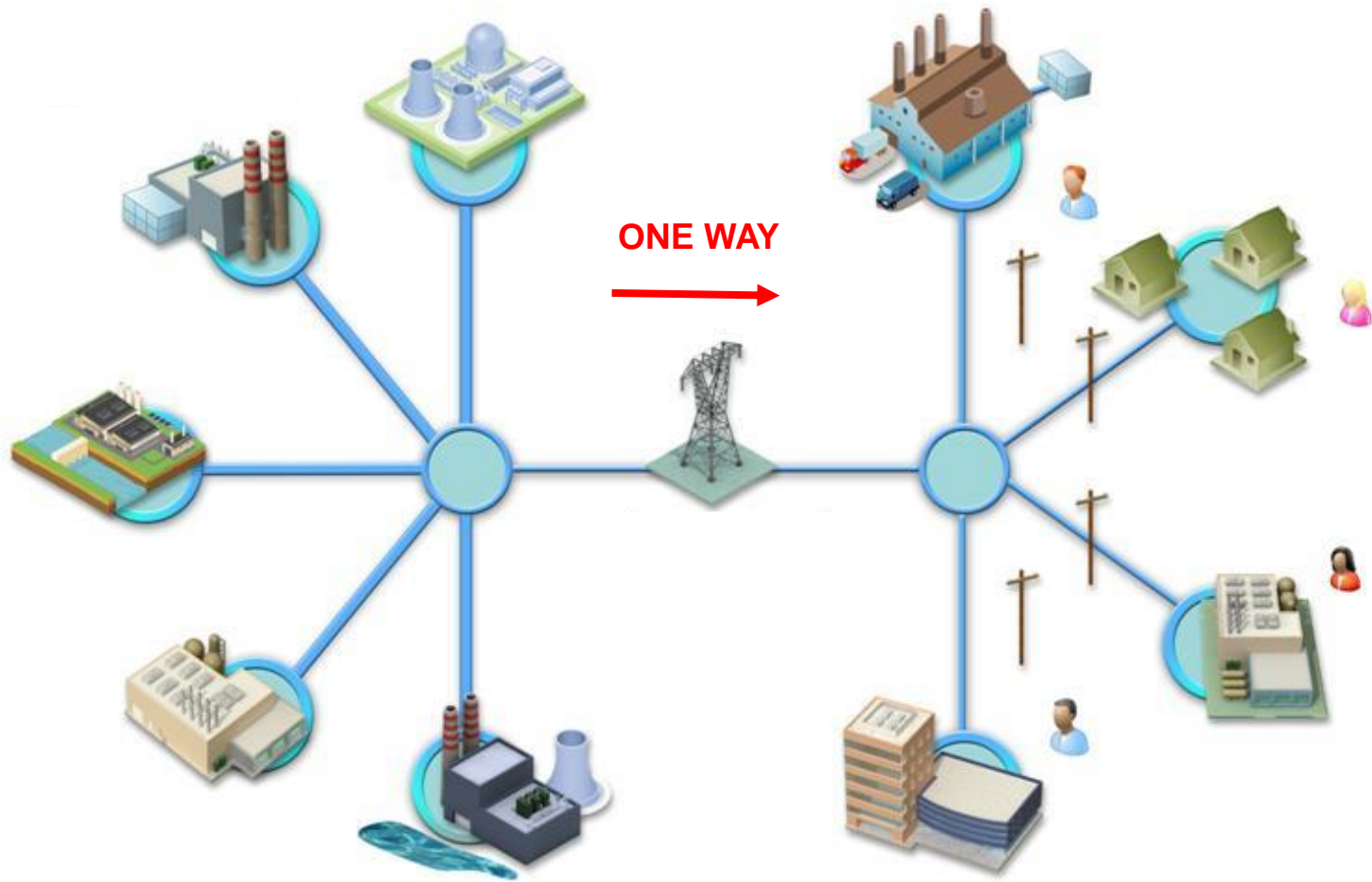
USEA Energy Supply Forum

Washington, DC – October 2, 2014



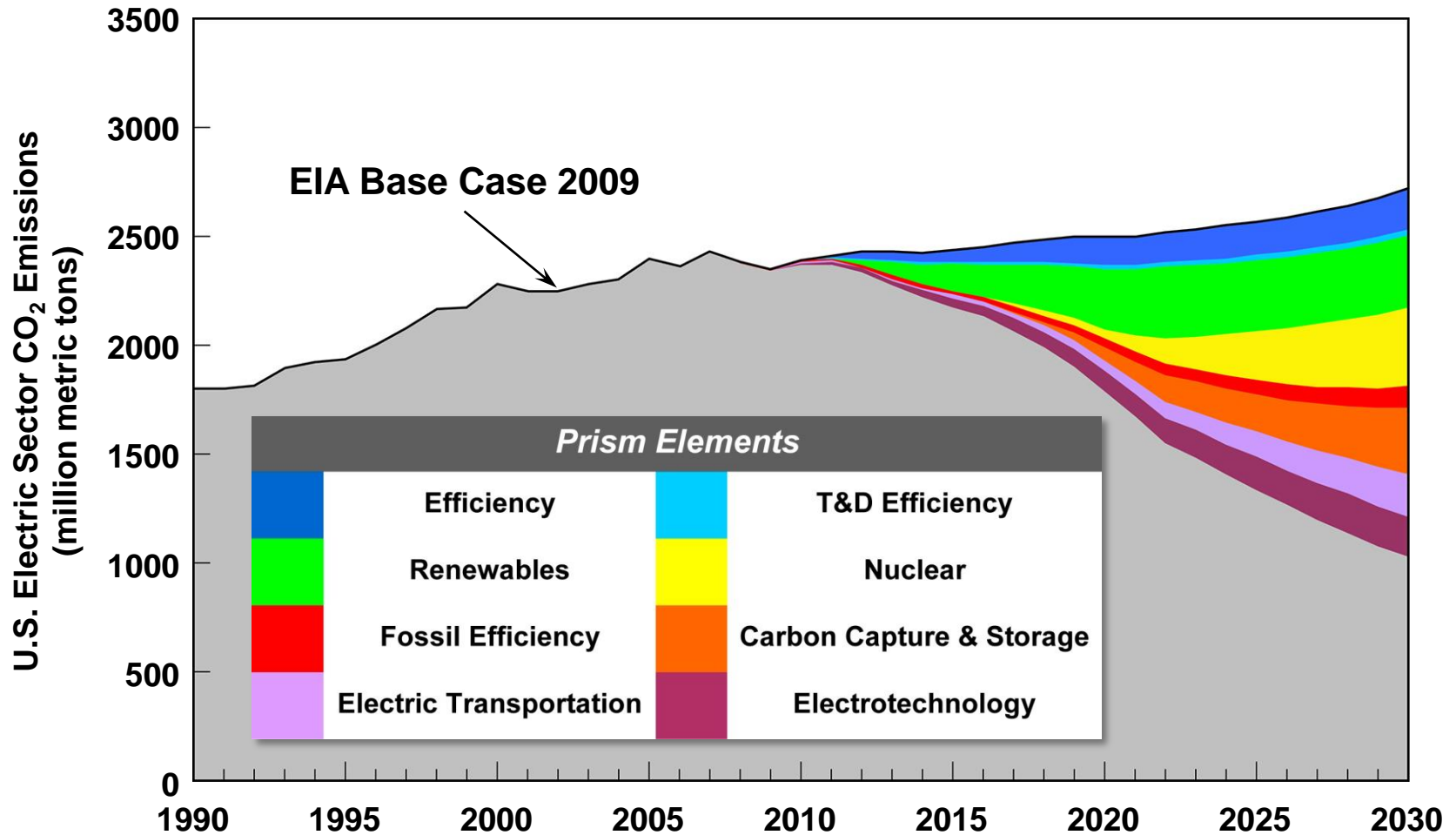
Let's Start with the Customer...

The Electric Power System



Power System Decarbonization

EPRI Prism (2009)



Emerging Technologies Driving Customer Engagement

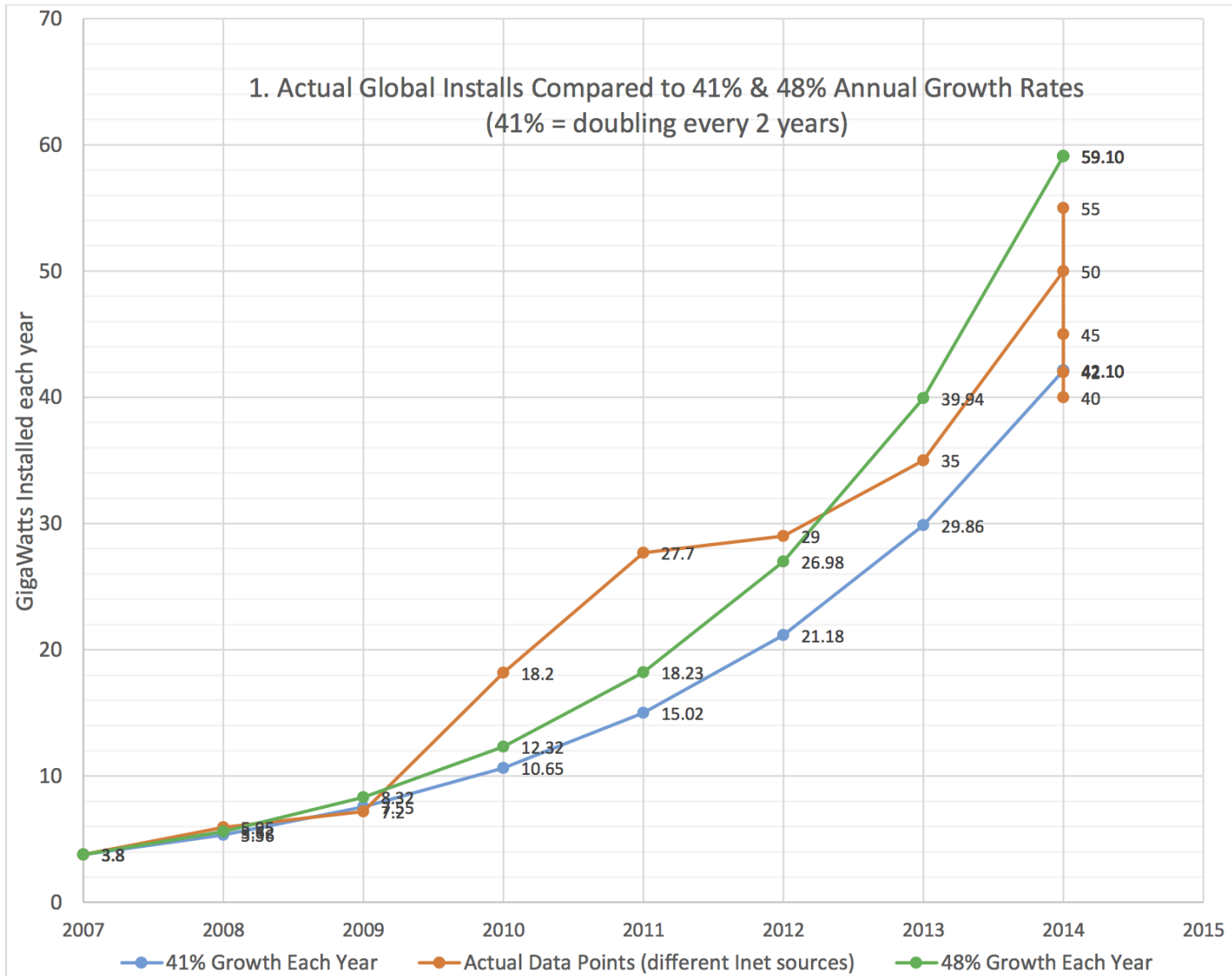


Increasing Variable Renewable Generation



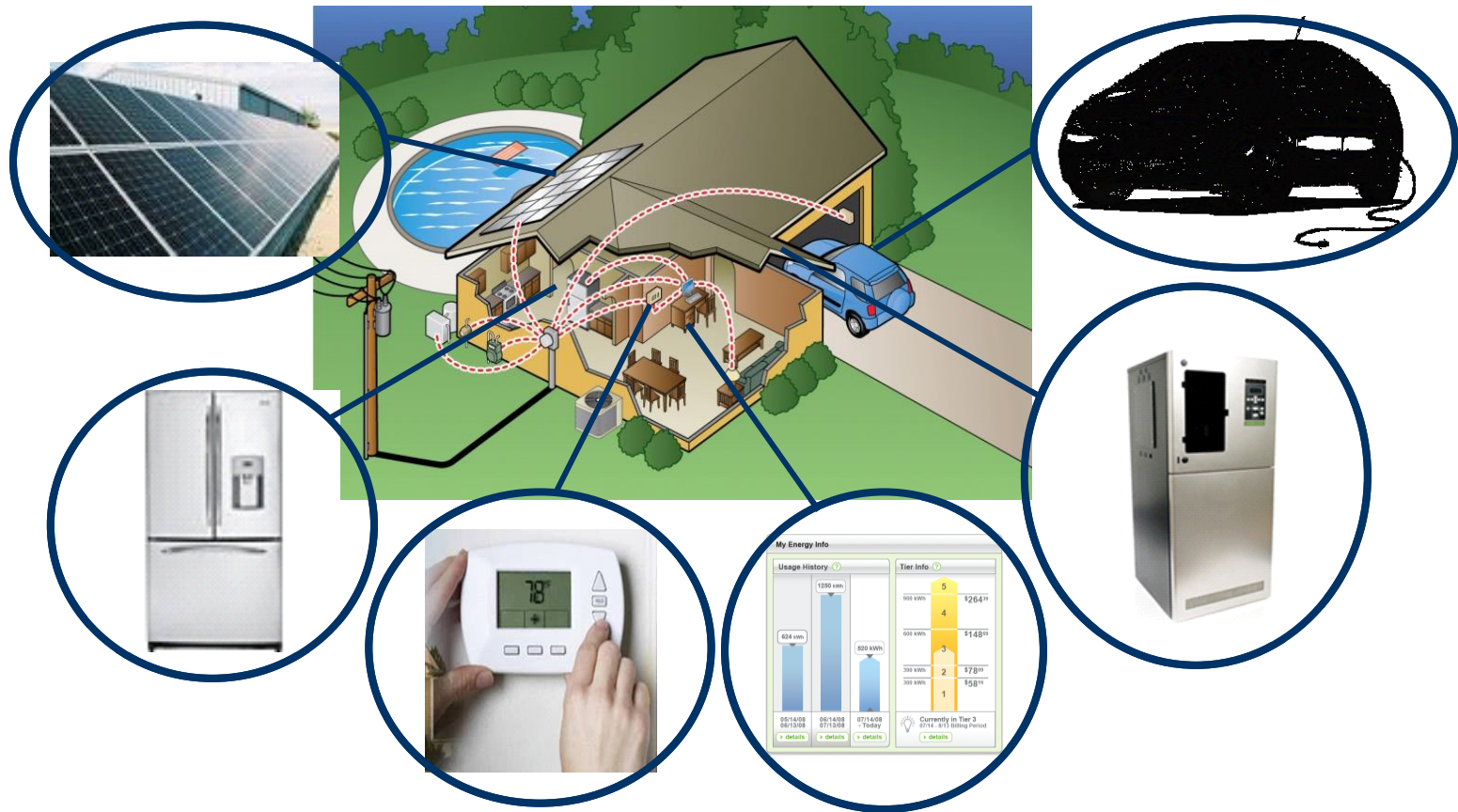
320 GW Wind + 134 GW Solar = ~8% of Global Installed Capacity

Global Annual Additions – Solar PV



Source: CleanTechnica

The Integrated Grid is about Enabling the Customer

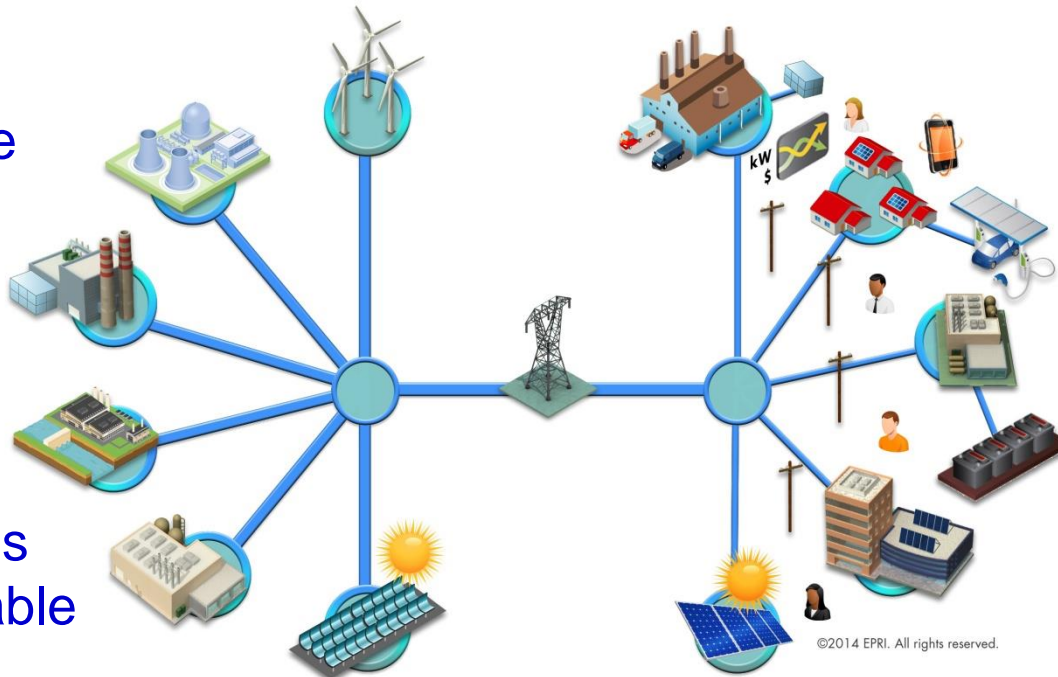


Enable Customer Resources to Benefit the Power System

So Where are We Headed?

The Power System – *Looking Forward*

- Generation Becomes More Flexible
- T & D Becomes More Controllable and Resilient

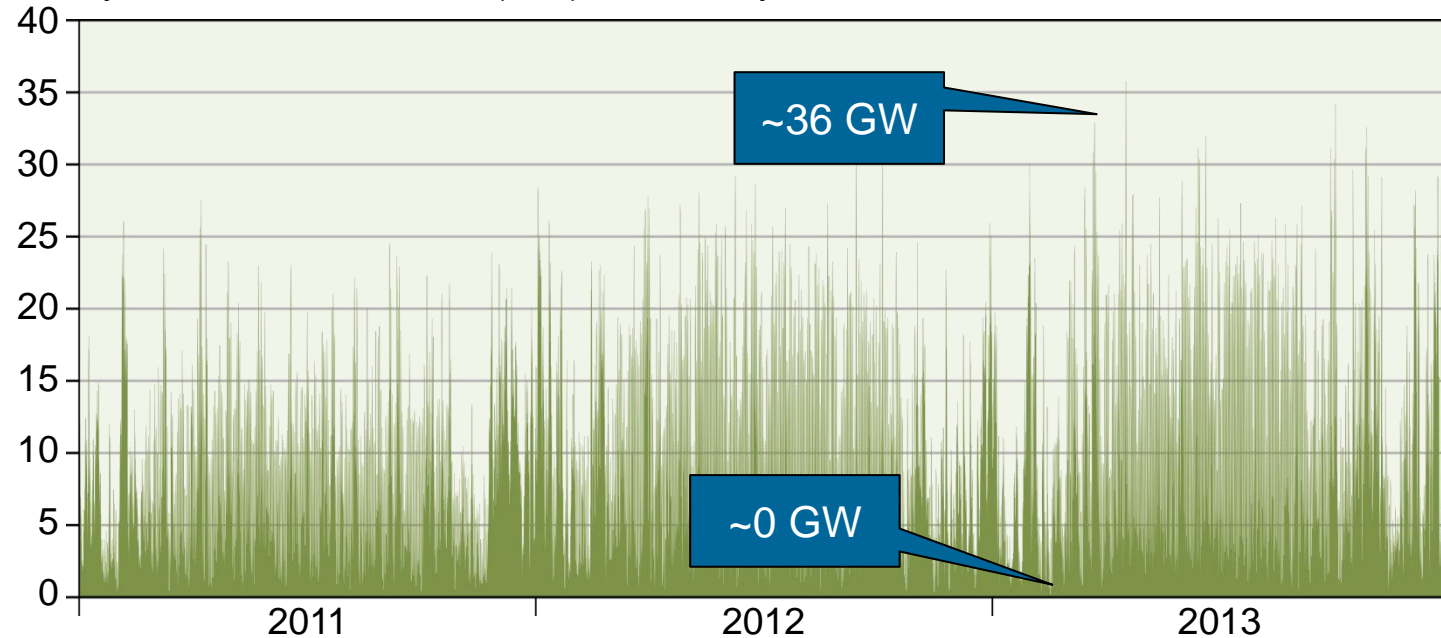


- Consumers Become Energy Producers
- Loads Become More Interactive and Dynamic

A More *Dynamic* End-to-End Power System

Insights From a Real Power System

Hourly PV+Wind Generation (GW) – Germany



Insights from a Dynamic System

~80 days/yr
variable generation
at below 5% of
installed capacity

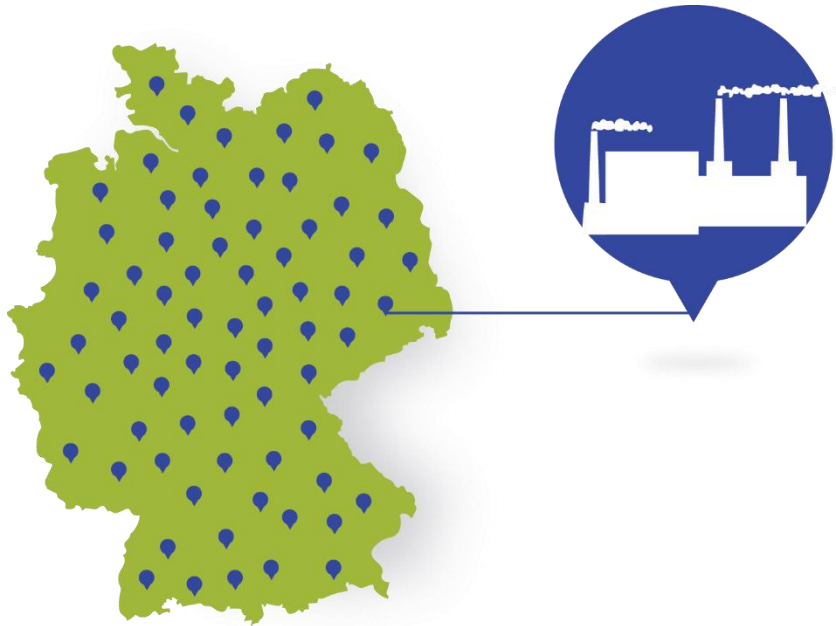
Maximum Hourly
Ramp ~10 GW

Maximum Hourly
Down Ramp ~7 GW

The Scale of Balancing May Become Unpredictable and Dynamic

Data from Klaus Kleinekorte, Amprion, German TSO.

Balancing the System... With Central Generation



~72

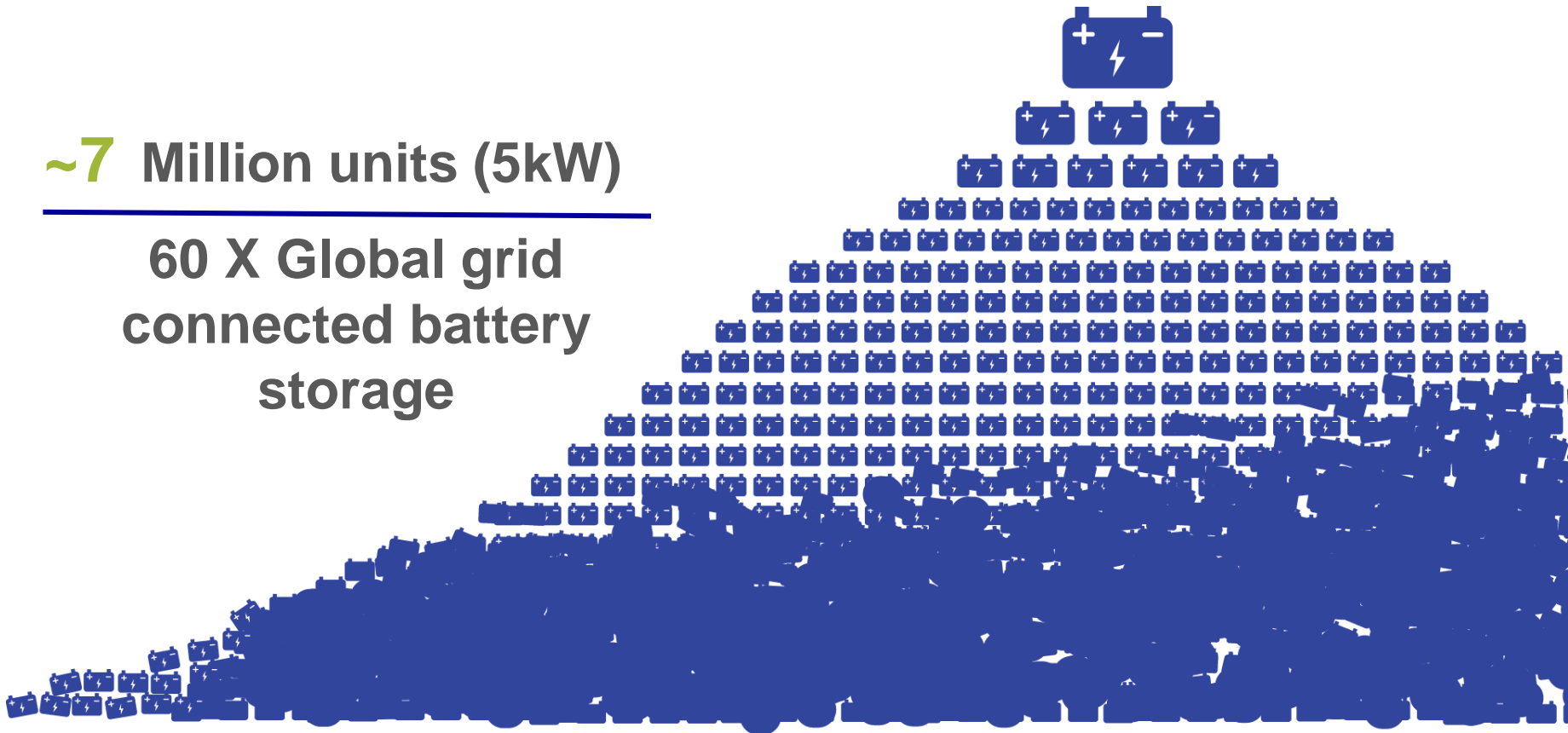
Central generation plants (@ 500 MW each) needed on days with minimum PV + Wind.

Balancing the System...

The Scale of Energy Storage Needed

~7 Million units (5kW)

60 X Global grid
connected battery
storage



Balancing the System...

The Scale of Customer Resources Needed

(Supplied Homes)

35,620,000

40,076,000

(German Households)

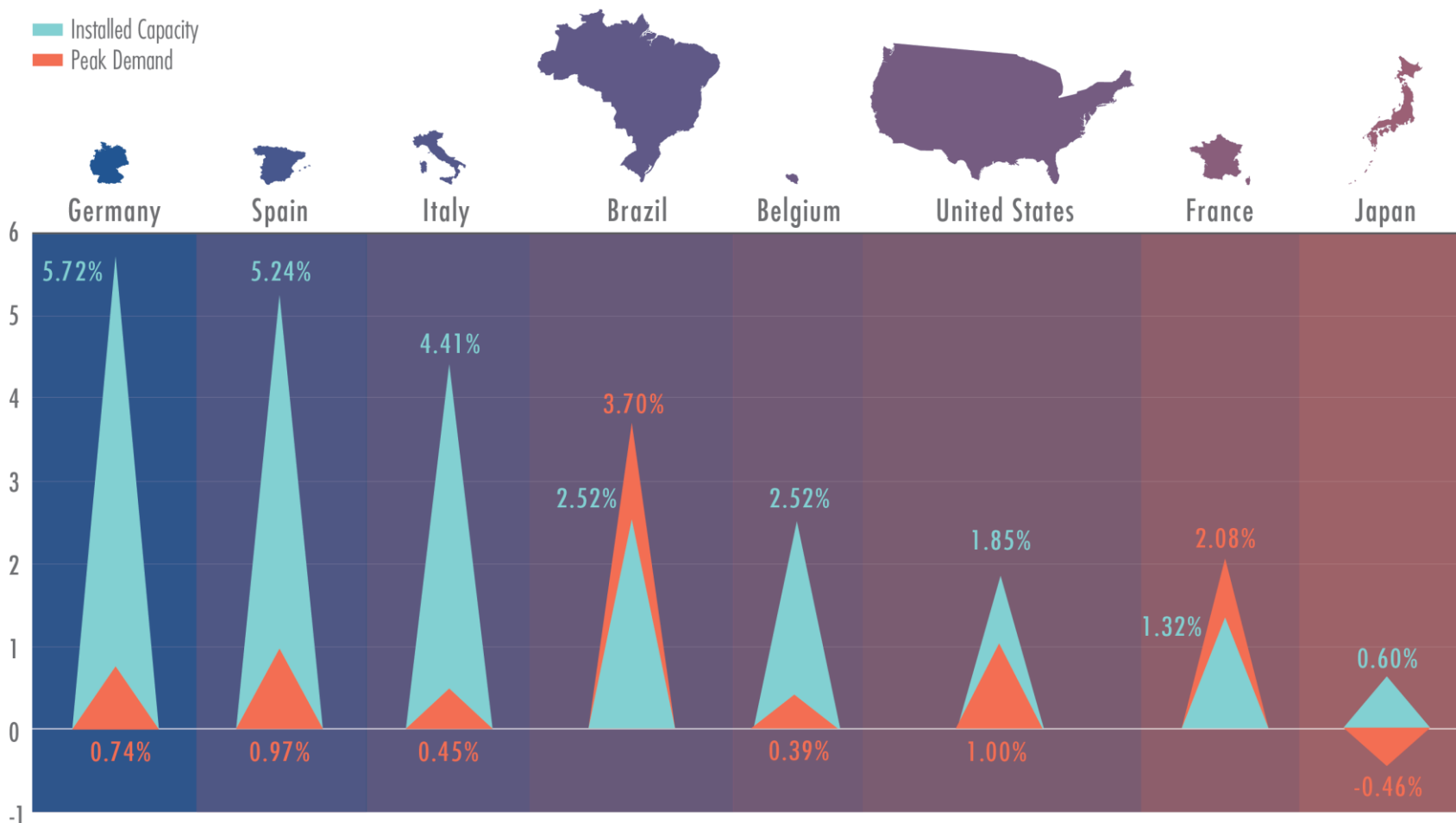


~**89** out of every **100** homes needed to supply resource, assuming each contributes 1kW.

Diverging Trend

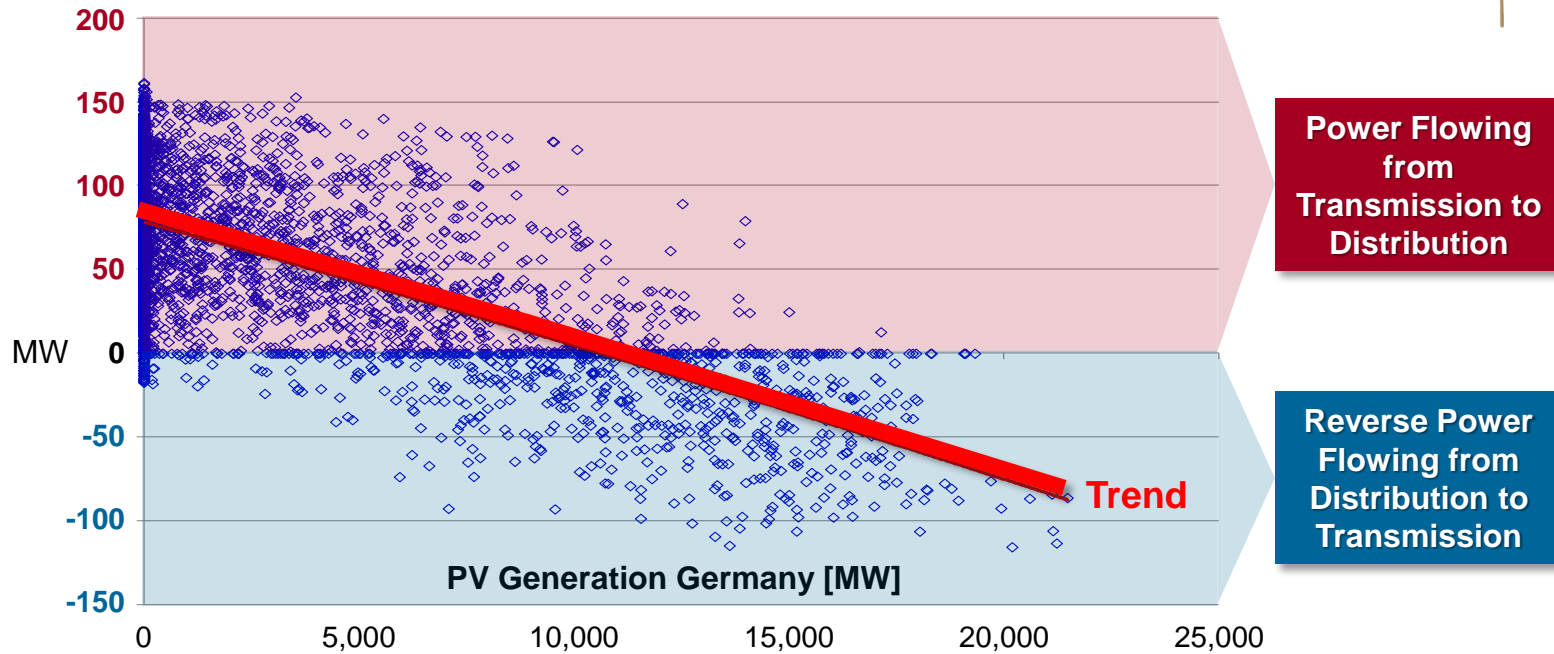
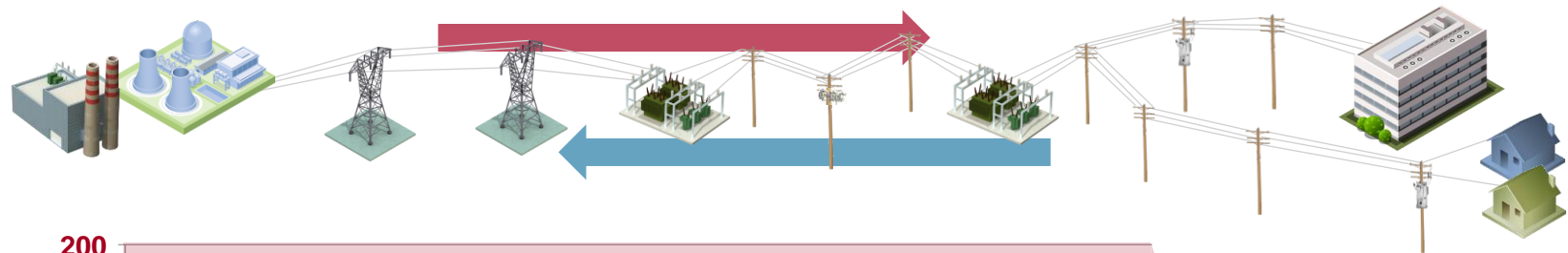
Installed Capacity Surpassing Peak Demand

Compound Annual Growth Rate (%), 2003-2013



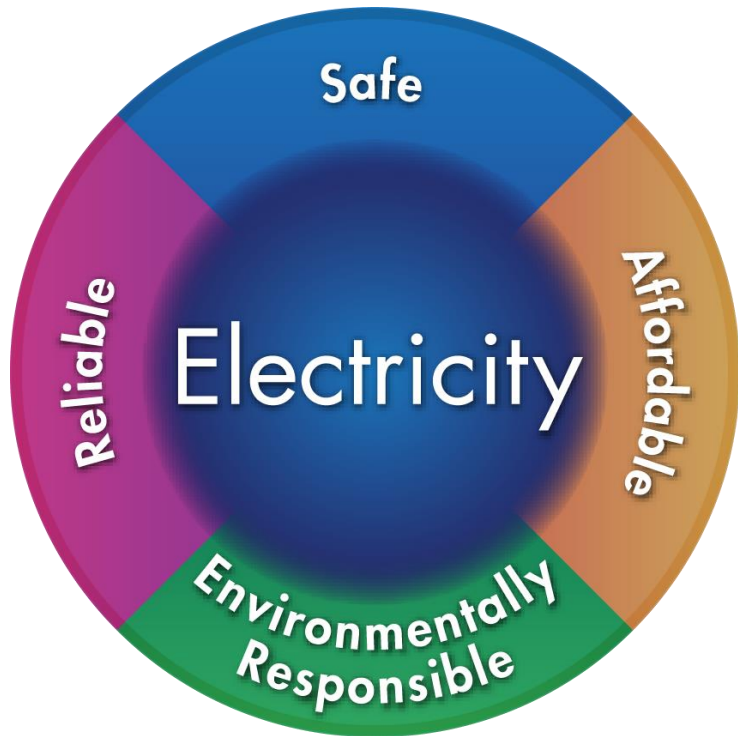
Data Sources: ENTSO-e and EIA

A Real Power System... When T&D System Becomes Dynamic



Data from Klaus Kleinekorte, Amprion, German TSO.

Power System Transformation



+



How Can We Advance the Conversation?

Integrated Grid – Action Plan



**Assessment
Framework**



**Interconnection
Technical
Requirements**



**Integrated
Planning &
Operations**



Enabling Policy and Regulations

Defining the Scenario - Assumptions

Markets and Policy

- Subsidies and Incentives
- Utility Obligations
- Reliability Requirements
- Energy and Capacity Markets
- Ancillary Services and Flexibility

Bulk System

- Resource Mix
- Capacity Resources
- Transmission Characteristics and Plans
- Technologies (HVDC, etc)
- New build assumptions

Distribution System

- Expected Renewable Penetration
- Load Growth, Efficiency
- Technologies (voltage control, smart inverters, etc)
- Distributed Generation and Microgrids

Societal Factors

- Cost of Carbon
- Value of Reliability
- Market Structures
- Energy Efficiency

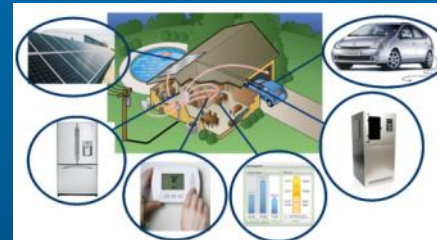
Critical Research Areas for the Integrated Grid

Architecture for the Integrated Grid



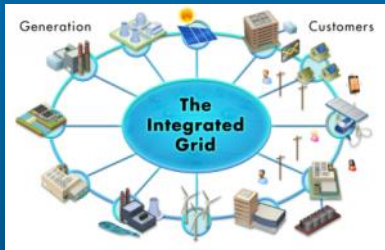
- Information and Communication Infrastructure
- Enterprise Interoperability
- Distributed Controls
- Open Application Platforms
- Cyber Security

Integrating the Customer



- Energy Efficiency
- Voltage Response
- Demand Response
- Local Generation and Storage (EV)
- Resiliency
- Customer Services
- CIS

Integrated Planning and Operations



- Integrated Models
- Advanced Simulation
- Real Time Systems
- Distributed Controls and Demand Response
- Risk-Based
- Forecasting and Analytics
- Visualization

Advanced Asset Management



- Sensors and Communications
- Advanced Analytics
- Maintenance and Diagnostics
- Reliability and Resiliency
- Visualization and Decision Support

The Path Forward

- We need an integrated approach to transform the power system
- EPRI's current research on The Integrated Grid is ready to be applied
- Industry and policy/regulatory leaders need to coalesce on key research imperatives for the transformation



Integrated
*The Whole is Greater than the Sum of
its Parts*

Transforming the Power System – It is a Journey not a Destination

Together...Shaping the Future of Electricity

Contact Me:
Ron Schoff (rschoff@epri.com; 704.595.2554)

Join the Discussion:
The Integrated Grid Online Community
<http://integratedgrid.epri.com>

WELCOME

THE UNITED STATES ENERGY ASSOCIATION

7TH ANNUAL
ENERGY SUPPLY FORUM

National Press Club
Washington, DC

