

#### THE INTEGRATED GRID

REALIZING THE FULL VALUE OF CENTRAL AND DISTRIBUTED ENERGY RESOURCES

MOTE HOME CO

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### **Electric Power Research Institute**



### Together...Shaping the Future of Electricity



### **The Electric Power System**





### **Looking Forward**





## **Interconnected but Not Integrated**



#### Integration Enables Values of all Resources



### **The Challenge – A Few Examples**

#### 24 by 7 Electricity









#### **Meet the Challenge**





## **Foundation of An Integrated Grid**

- 1. Grid Modernization
- 2. Communication Standards and Interconnection Rules



- 3. Integrated Planning and Operations
- 4. Informed Policy and Regulation



## **Action Plan**



#### **Global Collaboration to Establish the Science, Engineering and Economics**

## **Phase II of Integrated Grid**



#### Addressing Key Industry Research Gaps to Inform All Stakeholders



## **Building Upon Prior Efforts**



#### Many have contributed to specific aspects of the framework Need comprehensive approach: connecting all puzzle pieces



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## **Integrated Grid Framework**





#### **Assessing Distribution System Impact**

Feeder Hosting Capacity: A Brief Primer



## **Understanding System Impacts of DER**



## Leveraging Prior Work Cost Benefit Analysis (CBA)

#### "Methodological Approach"

 Jointly funded by EPRI the US Department of Energy and provides framework for estimating benefits and costs, Jan 2010

#### **CBA Guidebook**, Rev 2

 Provides a manual for practical application, with step by step instruction, Rev. Dec 2013





## **DER Interconnection Requirements**

**IEEE Standards** 

1547™-2003

Print: 8H95144

1547<sup>™</sup> IEEE Standard for Interconnecting Distributed Resources with Electric Power Systems

Standards Coordinating Committee 21

Sponsored by the Standards Coordinating Committee 21 on Fuel Cells, Photovoltaics, Dispersed Generation, and Energy Storage

The institute of Electrical and Electronics Engineers, Inc. 3 Park Avenue, New York, NY 10016-5997, USA 28 July 2003

IEEE

Future Interconnection Standards Should Consider

- Voltage Support
- Frequency Support
- Fault Ride-Through
- DER/DSO Communication

EPRI working on recommended technical guidelines for voltage and frequency ride through capability for DG based on new IEEE 1547a



## **Integrated Planning and Operation**



Establish technical requirements for transmission-distribution interface in a DER future

- Scheduling
- Real-time balancing
- Integrated markets
- Planning
- T&D operation
- Integrated System Modeling

#### **Requires a coordinated effort among all stakeholders**







#### **Together...Shaping the Future of Electricity**

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#### www.EPRI.com/integratedgrid

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# **Background Slides**

# **Modifying Connection Rules in Germany**





### **The Grid Provides Startup Power**



### **Grid Connectivity Reduces Harmonic Impact**





## **The Grid Provides Transactional Value**





### Germany's System Curve with Increasing PV



